CHEMICAL & METALLURGICAL ENGINEERING

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THIS MONTH

• For a time it looked as though this issue was going technocratic! All during January we carefully guarded a bulging file to which the members of the staff contributed everything from original ideas to the latest wisecracks of Mr. Will Rogers. But about Feb. 1 we began to lose interest and the file started slipping toward the editor's waste basket. Just before we let it go we salvaged a couple of editorials and a book review. If the reader will forgive us these, we'll try our best to forget the ugly word even though some of the lessons of this mad excursion into the limelight may stick with us for a long, long time.

• Our reference here last month to the use of chemical warfare in crime prevention has already brought us so many inquiries that we are beginning to wonder if some one has been tipping off the crooks. Incidentally Mr. Kobe's article was included in the "Notes From Business" program broadcast Feb. 4 from WLW, the Nation's Station in Cincinnati—which may have some bearing on its advanced popularity.

MARCH AND APRIL

• Next month the articles are going to deal with a most interesting history of the development of ammonia-soda alkali manufacture in the United States, with the march of progress in electrochemical industries, with dust explosions—their causes and prevention, with improved process control through the more intelligent use of instrumentation, with x-ray examination of welding and with chemical engineering design and construction.

• April's to be another special theme number—to review the important chemical engineering achievements of the depression. Here's where we earnestly solicit your advice. What in your opinion has been the most significant advance in your industry since 1929? Was it a new plant, process or product? A saving through the use of new or improved equipment? Or was it in management or research? We'll be glad to have your suggestions—in confidence if you wish—and just to prove we are in earnest we hereby promise by way of reward, to send each suggester a copy of a mighty useful conversion chart for temperatures and units of volume, weight and energy. Please address the editorial department.

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FEBRUARY 1933

VOLUME FORTY NUMBER TWO

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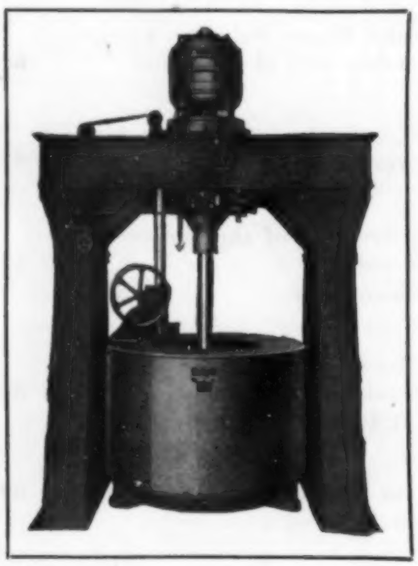

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CHEMICAL & METALLURGICAL ENGINEERING

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S. D. KIRKPATRICK, Editor

FEBRUARY, 1933

SOCIAL CHANGES AND IMPLICATIONS

SOCIAL CRITICISM flourishes most in times of depression. Dissatisfied with the existing order, many men begin to question the soundness of established institutions. With most of the world in such a frame of mind, it is only natural that science and engineering should come in for their share of questioning. This in itself is not to our discredit, but it explains best, perhaps, why such a futile movement as technocracy should spread like wildfire across the prairies only to leave behind the ashes of even greater discontent. Drawn unwillingly into this mælstrom, the engineer was caught off his guard and found himself unprepared to meet this distorted and destructive picture of his work. He needed badly the real facts and figures that would refute the gloomy portents of his self appointed representatives.

Fortunately, but in no sense a consequence of the squabble over technocracy, there appeared in the very midst of the excitement the calm and considered report of the President's research committee on social trends. When history records in true perspective the lasting merit of this work of more than five hundred specialists who directly or indirectly contributed to its two volumes, technocracy and those who exploited its cause will have long since been forgotten. This report is so comprehensive and so fundamental to all of our social and industrial problems as to warrant careful study and use not alone by those who are interested in the social sciences, but by engineers and technologists in every field. Here, if one looks for it, is the answer to most of the questions and criticisms that have been leveled so dramatically against technology and invention.

Here we find without the help of higher mathematics and the jargon of the technocrat, an impartial appraisal of the social consequences of the work of the engineer and the scientist. No effort is made to minimize labor displacement and technological unemployment, but on the other side of the ledger are cataloged the many great contributions with which technology has increased the wealth of the world, broadened our mental horizon, provided comforts and convenience, shortened our working day, built innumerable new industries and thereby created millions of new jobs. "Social changes of today are connected with inventions of the past and inventions of tomorrow will, no doubt, foreshadow the social changes of the future. . . . More and more inventions are made every year, and *there is no reason to think that technological developments will ever stop. On the contrary there is every reason to expect that more new inventions will be made in the future than in the past* . . . . and many new and unheard-of inventions are now in existence that will have wide use in the future."

Since 1900, while the population of the country has increased 61.5 per cent, the number of engineers has mounted by 445 per cent, the number of designers, draftsmen and inventors has increased 442 per cent, and the number of chemists and metallurgists, 420 per cent. In this period of greatest technological progress, the American people have made their most striking advances both in the cultural and material phases of our development. It is futile to believe that progress is at an end. Thanks to technocracy, the engineer is only beginning to sense the full potentiality in the social effects and implications of his work.

EDITORIALS

The President-Elect Dreams—Will the Tennessee Valley Boom?

FAR MORE than Muscle Shoals, the Norris-sponsored public ownership program, and the threat of increased competition for the fertilizer and electrochemical industries are involved in the fireside dream credited by the daily press to President-Elect Roosevelt. Newspaper men present at that interview state with all candor that they were merely reporting the fireside conversation in which perhaps the radiant energy of the crackling logs had warmed and enlarged the imagination of the speaker quite as effectively as it had cheered and warmed his anatomy. And yet, whether dream or not, this Tennessee River project cannot be ignored.

Mr. Roosevelt proposes that this venture be something of an experiment to see whether the plight of agriculture may not be relieved, power needs of a community better served, and a real economic advance achieved. If managed on a basis of sane engineering and sound economics, but without destroying the imaginative effort of one keen to accomplish social advance, such a program might well contribute materially to the nation's good. And yet there are many technologic pitfalls that must be avoided.

No sane engineer will question the desirability for further development upstream from Muscle Shoals of water storage and power enterprises. Whether the Government can afford to strain further its credit at a time like this to accomplish such development, is quite another question. Then, too, as to reforestation there is no simple answer. Unquestionably much marginal agricultural land would be better under forest control than when farmed as now. Such a principle is easy to enunciate; but to accomplish the changes involved in its application will be extremely difficult.

From the standpoint of the forest industries there will be still other questions. At the present time, as demonstrated in the pages of *Chem. & Met.* last October, we do not need more hardwood development. And in the Tennessee Valley one finds the greatest opportunity for reforestation with hardwood, rather than the much-needed softwoods for pulp and paper manufacture. Only as we may encourage regrowth and reclaiming of softwood lands can a genuine public service be expected from this colossal adventure.

Then one must settle many fundamental policy questions as to industrial power if he is to answer with finality the basic idea proposed by the President-elect. Fundamental, too, is the matter of using the public credit to build up increased competition in commodities already over-produced in other agricultural and industrial areas. How will the farmers of the Mississippi Valley react to plans for reclamation and increased fertilization of farm lands in order to produce a larger corn crop? How will the electrochemical manufacturers of the Kanawha or the Niagara and St. Lawrence valleys adjust themselves to industrial decentralization sponsored, if not financed, by our own government? Verily, the path ahead is full of pitfalls which can be easily avoided—only in a dream.

But the process industries are more concerned in these matters of power supply, Government competition, reforestation, and better land utilization, than any other like group, save perhaps the public utilities. Therefore chemical engineers must study the Tennessee project carefully. We must recognize in that project what appears to be a sincere effort at social betterment of a backward region. We must oppose unsound engineering and unreasonable economics; but still we must cooperate, even with some self-sacrifice at times, if the long-run over-all benefit can be proved to be real for the public as a whole.

Flexible Tariff Gets Court Support

TARIFF rates affecting sodium nitrite have been a subject of court contest for nearly ten years. On Feb. 6 the Supreme Court apparently closed the controversy with a decision that vigorously supports the present practice in administration of the flexible tariff law. In its decision the court unequivocally concludes that where a domestic concern furnishes confidential cost data to the Tariff Commission, these need not be disclosed to a foreign company which has refused to give similar data for the guidance of the Commission. This broad principle will be of comfort to American enterprises seeking relief under this part of the law. It will materially aid the Commission in its inquiries. It greatly strengthens the force of the law under present procedure. Chemical industry will welcome the decision and hope that it will accelerate effective action where differences in costs of production abroad and in the United States are subjects of inquiry.

What's Happening in Engineering Education?

CAN A COLLEGE EDUCATION, aside from its cultural and social benefits, be justified on a monetary basis? If so, are financially successful graduates above or below the average in scholarship? Which courses are best designed to give early indication of later success? Is participation in fraternity life and extra-curriculum activities a waste of time or a valuable part of an undergraduate's career? And finally, what is the trend of graduates into executive positions and what industries and what type of jobs within these industries offer greatest opportunity for self-improvement and financial reward?

Questions such as these have more than academic interest to most of us as we look back over our own experience or plan for those who are to follow us in our jobs and professions. They are particularly timely right now because our engineering colleges are facing new problems, demanding more than evolutionary changes in their educational plans and programs. A recent survey by *Engineering News-Record* reveals a serious situation. Income in practically all institutions

has fallen while enrollment stays practically the same, there being more upper-classmen but fewer entering students. Recent graduates have found it difficult to obtain employment and many have entered non-engineering work. Research has had to be curtailed because of inability to purchase equipment or provide adequate supervision. The survey concludes with the surmise "that current events will lead to a re-appraisal of the functions of the engineering college and to the development of a modified educational program." If such fundamental changes are in prospect, especially in the older branches of engineering, we can well afford to examine the records of a thousand graduates of the course in business and engineering administration at the Massachusetts Institute of Technology. As reported in the article by Mr. Anthony Anable, elsewhere in this issue, these records not only answer the questions asked in our opening paragraph, but indicate some basic considerations of policy that may have a determining influence on the future of engineering education.

After Technocracy— What?

TECHNOCRACY'S millennium has been postponed, indefinitely. Doom, then Utopia, which were just around the corner a few weeks ago, have slipped into the limbo of *mañana* and the world has returned to its brass tacks and its limping but still useful economic system. From fellow-chemical-manufacturer Howard Scott we have had our glimpse of the happy never-never land with its wealthy millions, its leisure, its unflagging employment—not to mention its energy determinants and "metrical" society. He has permitted us a brief but glamorous view of a paradise where, with the Golden Rule in one hand and the Energy Standard in the other, the engineer would be king, *ad infinitum—ad nauseum.*

Where has it gone, this vision? Born of hard times, it seized on the public imagination as no other economic nostrum has since the days of Bryan and bimetallism. It battened on refutation and fed on the ills of a depression-sick world. Its fallacies scarcely noticed, its truths seemingly new and startling, backed apparently by the same science that had discovered the equivalence of inertia and gravitation and had built the automobile, the movement gained such headway in a matter of a few months that bankers and business men hesitated, orders were cancelled and recovery all but lost its way. . . . But power is a heady thing and the organization collapsed, its more responsible members returning to their statistical research, the others to their soap boxes. The country settled back to reflect on the sorry trick and recall that human nature, for all our increasing energy consumption, is very much today as it was during those 6,000 "static" years from which we had been led to believe we had graduated.

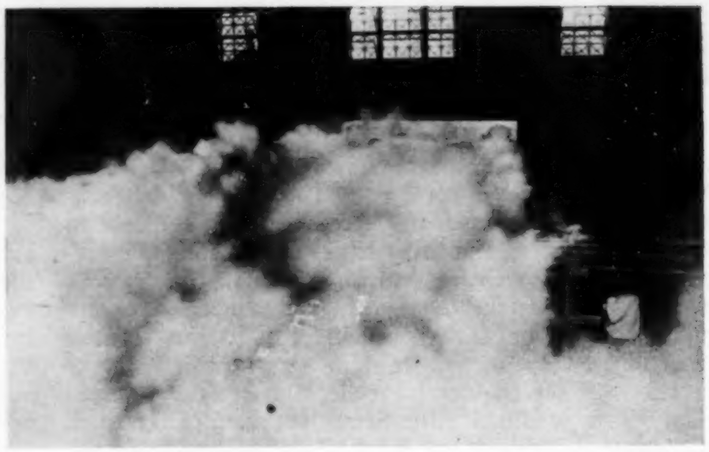
It was all pretty tawdry while it lasted; and yet something valuable is left. There was nothing previously unknown about its legitimate revelations but now they have been dramatized and thus brought into sharper focus. We can no longer ignore the uncontrolled growth of our internal debt, nor permit surpluses to close the vicious circle which prevents normal and reasonable consumption. We cannot continue to dodge the fact that increasing productivity under our present system carries in itself the germ of reduced consumption and that a too generous technology can breed want. It seems more and more evident that to restore purchasing power and maintain it, our living standards must be raised and our leisure increased.

These things are not incompatible with capitalism, provided that they are handled intelligently. Unbridled individualism can and must be curbed and production held within the bounds of possible consumption. This means not more but better government, not more but more intelligent competition. It means reduced hours and, very possibly, higher wages. But above all, it demands full recognition of the fact that producers are likewise consumers and that real wages which lag far behind production must inevitably lead to hardship and underconsumption. Once these simple principles are fully appreciated, we shall no longer need to fear the inroads of technology, nor the increase of energy consumption. Far from the calamity it would be today, the eventual unlocking of atomic energy will sometime be a boon, compared to which the first two centuries of the industrial revolution will be negligible. In the meantime, we must learn to live sanely. But, in spite of human nature, those 6,000 "static" years were far from static. Change has always been in the air, and today it is more hopeful than ever.

Investing In Man-Power

RIGHT NOW is not an easy time to raise new capital, especially if your business happens to be a small or little known enterprise. But we have recently learned of one company that raises the equivalent of $100,000 of fresh working capital every year or two. It does it by the simple expedient of adding a new $5,000 man to its production or sales staff. "When we need a new man," writes Dr. Arthur R. Maas of Los Angeles in *Southern California Business,* "we proceed by setting aside money for an investment somewhat like that for a new machine. We figure it will cost so much to locate a promising man and test him for six months, train him, let him demonstrate what is in him for our business, and if he does not measure up, let him go with the feeling that we have made a fair trial all around. . . . Until he has made his place we regard him as a research project and do not charge his initial salary to expenses. After the test period, he soon becomes a producer and an asset. We have had very few failures." Building on manpower is not exactly a "secret of success" but there is plenty of evidence to prove that organizations so built can exhibit greater strength and stability than certain large aggregations of capital.

By KENNETH A. KOBE
Department of Chemical Engineering
University of Washington
Seattle, Wash.



Tear gas foils a bank holdup
(Photo by Federal Laboratories, Inc.)

CHEMICAL WARFARE In Mob and Crime Control

INTRODUCTION of chemical warfare during the World War, and its rapid rise to importance as an offensive and defensive arm, brought to the attention of the country a new weapon. Unlike the rifle and pistol which possessed numerous peace-time uses, chemical agents had been the object of so much adverse propaganda that people looked upon them with horror. That much of this ignorance concerning chemical agents still exists is shown by the cry that arose when tear gas was used to cause evacuation of the Bonus Army camp in Washington, D. C. The training of a large number of men during the World War in the use of chemical agents, returned to civilian life a group of men fully aware of the potential value of chemical agents for offensive and defensive use against the criminal. These men have changed chemical warfare material to meet the needs of police forces, devised new kinds of equipment which can be used by the individual for the protection of his property or person, and continually carried out an educational campaign to show that the use of chemical agents is the humane method of handling not only criminals but also mobs. It must be remembered that the individuals in mobs—lynchers, for example—may be responsible citizens who should be handled firmly but without casualties. For this purpose chemical agents are ideal. For the protection of property chemical agents are proving their merits for they are quick acting and their persistent nature gives protection even after the device has discharged. Such a device can well be advertised as one that "fights back."

Just as chemical warfare has a history predating the World War, devices and chemicals to protect safes and vaults from illegal entry were patented at an early date. United States patents of 1871 and 1872, for instance, disclose chemical means for this purpose. Many other devices and methods have since been devised, differing only in the mechanical details or chemical agents used.

Chemical devices on the market at the present time for protecting safes against burglars may be divided into two classes. The first consists of a frangible container which is broken to release a volatile chemical agent; the other is a mechanical or electrical device which will detonate a grenade to volatilize a chemical agent by a burning charge. The first type employs a glass container which is placed on the inside of the safe door behind the combination tumblers. When the spindle is driven back it breaks the container and allows the volatile chemical agent to escape. The use of explosives would likewise break the container and liberate the chemical. Present-day devices of this sort contain chemical agents such as chloropicrin, bromacetone and other lachrymators which will readily volatilize without the application of heat. The second type contains a lachrymator such as chloracetophenone which, being a solid at room temperature, must be volatilized by the application of heat. The chloracetophenone is mixed with nitrocellulose and the charge ignited with a detonator, the heat of combustion of the nitrocellulose subliming the chemical as a cloud of tear gas. The safe protector is placed on the inside of the safe door and a firing plunger is held up by a tension wire which passes through a shearing block connected to the rear of the combination spindle. Any attempt to drive in the spindle puts pressure on the shearing block and severs the tension wire. The firing plunger then hits a percussion cap, ignites the burning charge and volatilizes the lachrymator. To extend this protection to the entire safe door it is merely necessary to wind the tension wire back and forth over pulleys until it guards the entire surface, and if desired, other sides of the safe as well. Although it is exceedingly effective when ignited, the sublimed chloracetophenone is quite persistent and rather difficult to remove from the premises.

This safe protector is merely a modified hand grenade and by changing the manner of detonating, the grenade may be modified for many other purposes. One form is the "gas lock" which is being used to prevent the forcing of doors. To combat daylight holdup of banks a gas system has been developed which can be operated from the tellers' cage or lobby desk. A gas cartridge is fired electrically and the lachrymatory vapors conducted through a short length of tubing to escape into the room through inconspicuous outlets.

Chemical equipment has become an important part of every police department and its use and misuse, as reported in the daily press, has made the public conscious of the effectiveness of tear gas. Most of this equipment is a modification of that used during the War or developed by the Chemical Warfare Service since that time. Usually smaller quantities of chemical are employed since the agent is more often used indoors. Too sparing use of the smaller grenades in outdoor riots has sometimes been ineffective, as in the Dearborn riot.

Hand grenades are of several types. The striker type (sketch 1) is a modification of the rifle grenade and requires the withdrawal of the pin and the striking of the plunger against some hard object before the grenade is thrown. The automatic type (2) requires the withdrawal of the pin, but when the grenade is thrown from the hand a spring throws out the lever on the side and detonates the grenade. The success of mobs in hurling grenades back at the police has brought out a type which immediately produces a tear gas cloud when the side lever is thrown out. Tear gas, smoke or irritant smoke may be used in these grenades. Chloracetophenone mixed with nitrocellulose is employed in the usual tear gas grenade. Hexachlorethane, zinc powder and zinc oxide produce a dense white smoke for screening purposes, or to simulate gas clouds for training purposes. Where the situation is more serious than the usual riot a grenade using diphenylaminechlorarsine may be employed. This substance is one of the irritant smokes or "sneeze gases" used during the War, and though it is odorless it soon causes nausea and vomiting, headache and a sense of suffocation. Whereas the effects from tear gas soon disappear when the person leaves the gas cloud, the effects from the irritant smoke last from several hours to an entire day, but leave no permanent injury. There is also a grenade (3) in which a liquid tear gas, such as chloropicrin, is sealed in a glass container and surrounded by a soft copper shield. When it is thrown against a surface the glass is broken and allows the liquid to volatilize without explosion.

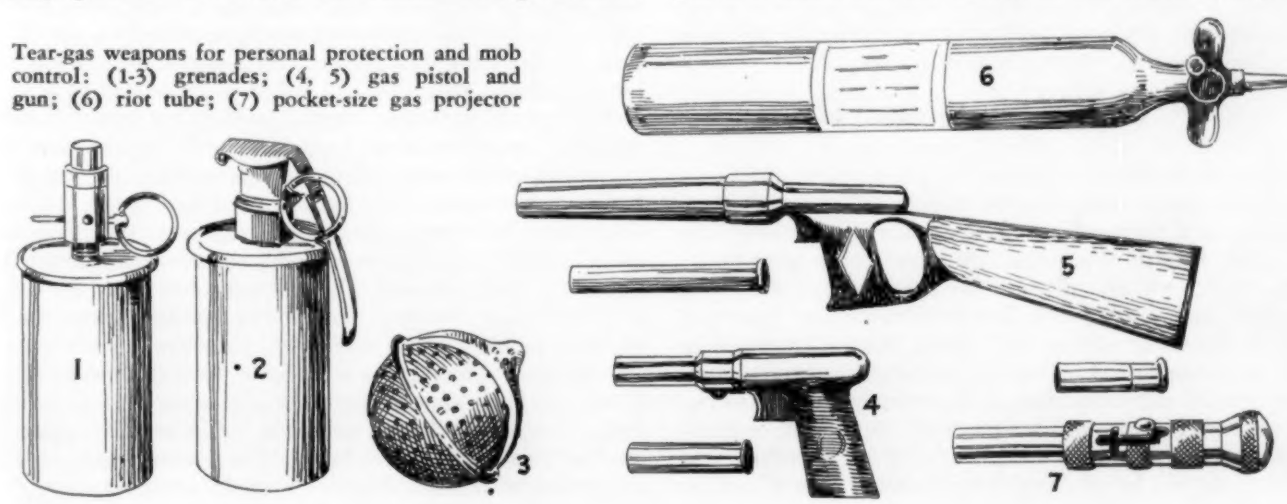
The tear gas pistol (4) is a development of the old Very signal-light pistol. It uses a cartridge 1 in. in diameter, similar to a shot gun shell, in which the shot and part of the powder charge are removed and replaced by a nitrocellulose container filled with chloracetophenone dissolved in ethyl bromacetate. The spread of gas on discharge gives a 9-ft. circle at the maximum range of 30 ft. A barrel and trigger in the form of a police billy is made to discharge a 12-gage shell. For longer range work the gas field gun (5) is employed. This weapon uses a cartridge $1\frac{1}{2}$ in. in diameter and 8 or 10 in. long. Various kinds of cartridge charges may be employed, as tear gas shells, smoke screen shells, illuminating star shells with parachute and colored star signal shells. The 10-in. shell discharges a projectile which detonates on striking a hard surface or by a time fuse eight seconds after firing. Such a projectile is especially adapted for forcing evacuation of a barricaded space, as its range is 450 ft. The 8-in. shell fires a gas cloud with a spread of 15 ft. at its range of 35 ft., so is suitable for riot use.

The latest development in police equipment is the "riot tube" (6) for use against mobs. This is a steel cylinder with a valve at the end. It contains a liquid tear gas, or tear gas and a smoke producer such as stannic chloride, under high gas pressure. When the valve is opened the liquid is sprayed out and immediately vaporizes to form a cloud. This tube has several advantages over the gun type of equipment, since its discharge can be controlled in amount and direction and will last over a period of time. A smaller size is made in the form of a police billy.

For individual protection, the fountain-pen type of gas gun is rather well known as numerous styles have appeared, for sale to the public. They use a .38 caliber extra-long pistol shell or a .405 caliber rifle shell. The latter contains about 4 c.c. of liquid gas in a nitrocellulose container and has a spread of 3 ft. at maximum range of 12 ft. Accurate shooting at short range is necessary to secure results. The pocket size gas projector (7) is a larger weapon, using a 20-gage shot-gun shell with chemical. The spread of gas on discharge gives a 4-ft. circle at the maximum range of 15 ft.

Tear gas still remains very much of a mystery to the general public. The fear of the unknown makes chemical agents exceedingly effective in riot duty, but the same ignorance prevents responsible people from making use of chemical equipment in the protection of their persons and property. Only demonstrations will convince the uninitiated of the many advantages of such equipment. Unfortunately a skeptical attitude is taken by many police officers who prevent their departments from obtaining and using tear gas. Those familiar with the many advantages should aid in educating the public that tear gas is a useful servant as well as a dreaded enemy.

Tear-gas weapons for personal protection and mob control: (1-3) grenades; (4, 5) gas pistol and gun; (6) riot tube; (7) pocket-size gas projector



What the School of Experience Has Taught a Dye-Plant Operator About Construction Materials

By A POST GRADUATE

RAW MATERIALS used in dye plants include a large assortment of chemicals and intermediate products, which must be handled in all physical stages, gaseous, liquid and solid, at high temperatures and pressures. Numerous corrosion problems are thus encountered, and the equipment is subject to a wide range of conditions, so wide, in fact, that almost every known material of construction finds application. As a full discussion of the materials used necessarily would include many data without particular interest, the following review will be confined to the more outstanding applications.

Generally, association with conditions in a dye plant quickly develops a tendency and ability to consider all construction materials and plant products in view of their relation to corrosion; this is the gage by which a material is found suitable or of no value. The lasting qualities are the primary consideration; closely connected with these is the question of first cost, as available funds generally impose certain limits which prevent the selection of a material otherwise most suitable. Conservatism on the part of the official who signs appropriations often creates some unexpected, often enlightening incidents when substitutes must be resorted to. To illustrate this point, an appropriation for a certain installation had become exhausted, with no funds remaining for equipment needed for dissolving iron in hydrochloric acid. As a temporary expedient two cast-iron pots, salvaged from the scrap yard, were imbedded in cinders, an acid hose was lowered from an upper window, and a "two-by-four" was donated for use as an agitator. Not a scientific installation, but a suitable one for, after eight years of operation, the pots are still good, the two-by-four has been replaced only twice, and no one has ever thought of asking for a change.

Selection of Materials

Selection of the basic materials for equipment is governed by general conditions pertaining to corrosion, temperature, and physical properties. Certain general factors soon demand attention. A caustic process suggests iron, steel, nickel alloys, or pure nickel. Strong inorganic acids—except hydrochloric—suggest iron and steel in the early stages, with lead, bronze, or wood as dilution proceeds. Hydrochloric-acid processes suggest glass, special alloys, rubber, and earthenware. A nitric-acid process involves chromium steel, aluminum, or high-silicon cast iron. Following this line of reasoning the "don'ts" should be of equal importance. Zinc alloys, or aluminum must not be used with caustic liquors; copper alloys should be kept away from nitric acid; soft rubber must never be exposed to hydrochloric-acid fumes, nor brass to ammonia. In spite of the corrosion complex cast iron and steel still remain the mainstays of the equipment designer; this is largely due to their lower price.

Skill of Foundry Men

As a rule the chemical engineer does not realize the skill which can be exercised by the average foundry man, who in turn has little conception of the former's needs, all because they do not speak the same language. The drawings of some cast-iron equipment may be sent out for estimates with the enlightening specification that a good grade of cast iron, free from imperfections, must be furnished. Under these conditions the average foundry man usually quotes for a nice, clean-looking piece of gray iron, probably a wonderful tailstock for a 36-in. engine lathe, but not at all suitable for the bowl of a caustic kettle. On the other hand, little would be accomplished by merely telling the foundry that the equipment is to be used for a certain chemical product as it generally has no conception of what that means. Both parties must forget their secrets temporarily and discuss the problem.

An illustration or two will emphasize this fact. Caustic dehydration pots have been manufactured for years and the foundry man has had an opportunity to make observations at close range with the result that excellent pots are made. Subjected to this service any other cast-iron kettle in the plant would last but a short time. The results so happily attained may be credited to the fact that the foundry has become fully acquainted with the requirements.

Another illustration, more specific, but equally outstanding, was furnished by a battery of machines used in reduction of nitro-benzene with powdered iron and hydrochloric acid. The kettles used had internal liner plates and agitators of ordinary cast iron which wore out so rapidly, due to the scouring action of the iron, that not more than one-half of the equipment could be used at one time. Average life of the agitators was three months, of liner plates about eight months. This situation had been accepted as one of the necessary evils of the process. Then appeared a man who knew enough about both foundry work and chemical equipment to appreciate that this did not have to be. The matter was taken to a foundry with frank discussion of the requirements. As

a result an iron was produced that was so hard, that no drill could dent it, yet tough enough to permit transportation and the pounding necessary to assemble the equipment. Average life of agitators went up to 14 months; of liners to two years, and the whole battery remained on production. The new iron cost 1c. per lb. less than the old, because of its large content of scrap.

Next to cast iron in general utility value are the bronzes, particularly the aluminum and manganese types. Now that the latter type can be purchased in plate and pipe form on short delivery, while rods and bolts may be obtained from stock, the troubles in dye plants are materially lessened. As long as these alloys could be had in cast form only their field was limited; with plates and pipe available bothersome lead linings or lead-covered coils need no longer be used in weak sulphuric-acid solutions. Aluminum bronzes of one composition or another give excellent service in both sulphuric and hydrochloric-acid processes. These alloys have great strength, high heat conductivity, and remarkable corrosion resistance.

Before going too far and creating the impression that allocation of alloys and iron mixtures to proper corrosion service is a simple matter of laboratory test alone a solemn warning should be sounded. This is not the case. Plant equipment involves many factors which simply cannot be duplicated in the laboratory; all decisions involving fine points should be supported by observations in the plant. Even then one is not justified in sitting back complacently, thinking that the problem is solved. An example or two will illustrate this thought.

Operating Experience

The equipment of an old process was being shifted to another plant to effect consolidation into a small number of large units. One step in the manufacture was the production of aniline hydrochloride; the addition of hydrochloric acid to aniline had always been done in small cast-iron kettles with agitators of the same material. The large 1,500-gal. units were equipped in the same manner, but operation disclosed that the agitators would last three batches only. This was not surprising, as 3,000 lb. of 22 deg. hydrochloric acid was used. Incidentally, no one quite understood why the equipment in the old plant withstood the punishment so well, but as it did, the new plant had been patterned after it. As quick action was necessary to remedy this alarming situation, an agitator and shaft of 89:10:1 (copper, aluminum, iron) aluminum-bronze was installed. This metal lasted through 12 batches (11 days per batch). At each failure everything was minutely examined for some clue that might reveal the cause of the difficulty; on one of these occasions it was noted that all of the square 1½-in. nuts were in better shape than the other parts. Persistent inquiry eventually brought to light the fact that the foundry, in filling one order, forgot to pour the nuts of the 89:10:1 mixture and at the last moment cast them from a 90:10 mixture for some other customer. Based upon this uncertain evidence the next agitator was made of the 90:10 mixture and the life immediately increased 50 per cent, or to 18 batches.

Further experimentation finally led to the adoption of a patented aluminum-bronze of the 88:10:2 composition. The first one installed lasted 68 batches (four years), before failure occurred; the other four are still in operation. A cast-iron agitator cost $76 installed, a bronze agitator $500. Considering the scrap value of bronze and disregarding time lost in repairs, bronze agitators saved $3,800 per year for the department. This is a rather striking example of the different action of varying compositions of the same alloy under otherwise similar conditions.

Cast Iron Kettles

Now, a word as to the cast-iron kettle itself, under the identical conditions. These vessels have 3-in. walls, which, if of uniform and clean composition, are reduced to a thickness of ½ in. at the solution line before giving way to the 90-lb. jacket steam pressure. At this stage from 75 to 80 batches have usually been completed, at a cost of about one-seventh cent per pound of product. Cast of bronze or lined with enamel these kettles would cost six or seven times as much as iron; they would, therefore, have to last at least 15 years. Who can be sure that the process will be in use at that time?

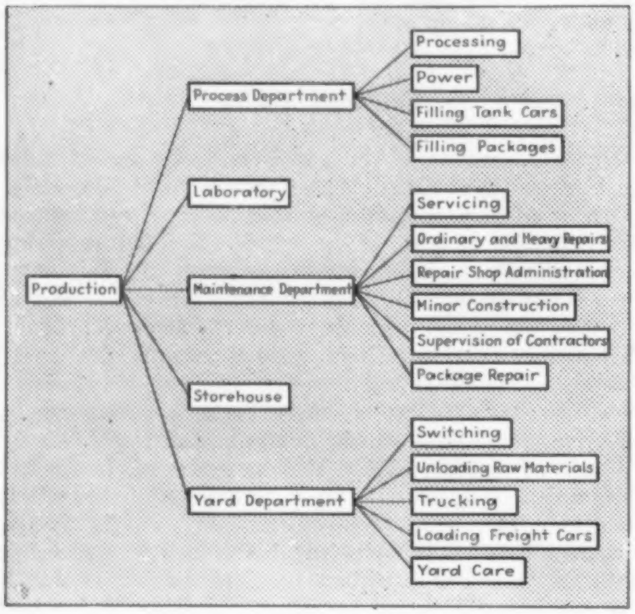
Quite advantageous, but seldom practiced, is the use of rough cast-bronze nuts on external steel bolts, where these may have to be removed in a hurry. This applies particularly to cover bolts and bolts used in removable flanges. When undisturbed for long periods the bolt and nut invariably rust together, requiring sledge and chisel work, generally awkward and dangerous around the crowded piping of the apparatus. If the nut is frequently removed, as in placing blow pipes, the threads become worn. Use of bronze nuts—the inexpensive type—will overcome these troubles.

Rubber for hose and tank lining is familiar to all, but the use of sections of acid hose with pinch cocks to reduce valve expense on corrosive work, where no great pressure is involved is not commonly known. This device requires only a 24-in. standard acid hose pinched with a steel clamp. This rather severe treatment of the hose eventually leads to broken walls, but the part is easily replaced and the whole cost is far less than that of a special valve.

Various alloys such as copper-nickel, nickel-chromium, and nickel-molybdenum all have their merits in the prevention of corrosion or of contamination of product, but their high cost often precludes a more general application.

Discussion of materials for dye-plant equipment would be incomplete without mention of the pressed and molded phenolic compounds, materials which come nearer than any other to being universal corrosion resistant. They seem to be wholly unaffected by the majority of chemicals encountered in a dye plant and have physical characteristics suitable to construction purposes. With such qualifications one would expect to find this material in common use, but such is not the case. Application has not advanced beyond the stage of bolts, rods, and a few smaller appurtenances. Cypress wood, the only suitable material for color vats, is becoming more scarce each day and the thoughts of substitutes constantly present themselves. A better material than the phenolic compounds for such equipment can hardly be visualized. But, even though vats in chemical plants are numbered by the thousands, only within the past few months have the plastics manufacturers developed materials suitable for this use.

THE CHEMICAL PLANT EXAMINES ITS MAINTENANCE POLICY



Separation of functions in a chemical plant's production set-up

By FRED. D. HARTFORD
Mechanical Engineer
Denver, Colo.

Maintenance departments usually handle minor new construction in chemical plants—

IN ITS EARLY HISTORY the chemical plant, or any industrial plant for that matter, is marked by a unique characteristic. During the first few months, every man connected with the plant, from the superintendent to the most unskilled laboring man, is dedicated to these ideas, "get the plant going, get the kinks worked out, bring it up to production." Any distinct lines of position or even of authority are not sharply marked. The superintendent may lend a hand at tightening a belt, or a handy man may be stationed at a pyrometer. A hard pressed operator may install a piece of pipe, or a pipe fitter may be called on to muck.

After the process has developed into a routine, however, the two functions, processing and repair, become distinct. True enough, the superintendent sees them both as expense and, accordingly, strives to make the sum of their costs a minimum, but he finds he can better control these costs when he makes a clear differentiation between the functions themselves. Thus, he establishes either informally, by word of mouth, or formally, by means of bulletins, definite operating policies, so that each department and all members of departments may understand precisely their duties in forwarding the aims and purposes of the plant.

But, as any plant superintendent knows, policies that at once define briefly the best methods of doing things, and at the same time cover every situation that arises, are difficult to formulate. There is a broad twilight zone wherein processing and maintenance are so closely intermingled that any statement fixing a sharp line between the duties of these two departments merits careful consideration.

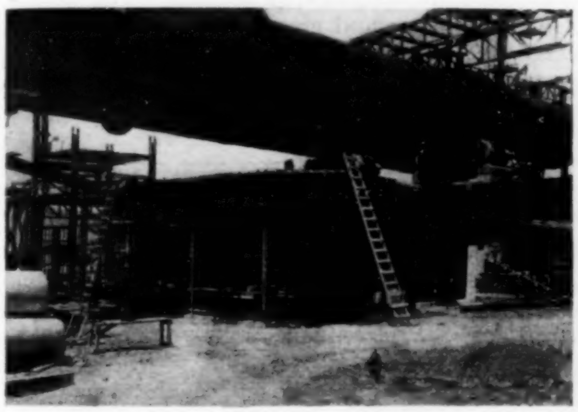
For example, some chemical plants may give their process men kits of tools, brooms, and window-cleaning compound, and instruct them to act accordingly. In such a plant, maintenance men are called on only when their special craftsmanship is indispensable. In one plant I knew, the process men even had their own lathe on which they refaced valves and fittings "in between times." Due to the exceptional skill of the process foreman in charge of this unit, this procedure succeeded in producing very low total production costs.

At the opposite extreme, and I think this is the direction in which chemical plant management is tending, one plant manager I know, becoming exasperated at the little deviations from established optimum operating conditions excused under the plea that certain "chores" had to be done, issued orders to his process men that they should have no tools whatsoever; not a hammer, nor a wrench, nor a piece of waste. The sole duty of process men, the order stated, was continually to patrol their stations, tak-

ing pyrometer and manometer readings, adjusting valves, rheostats, speed controllers and drafts, to the end that the reactions, heat transfer, and absorption were each to be held at the very pinnacle of efficiency. For any mechanical disarrangement whatsoever, at any hour of the day or night, they were to call the maintenance department and were to hold it responsible for making rapid and workmanlike repairs. Only the gravest emergency could excuse any deviation from these directions.

The increasingly exacting standards to which both process efficiency and mechanical repair are held, seem to indicate that such operating policies will increase in vogue. If such is the tendency, let us examine the maintenance function critically so that we may formulate a policy that at once produces a minimum of cost and a maximum of desirable results.

Considered narrowly, the maintenance department of the chemical plant has three distinct offices: (1) servicing or routine inspection, cleaning, oiling, packing, and adjusting; (2) ordinary running repairs that can be handled by the normal number of craftsmen; and (3) heavy repairs and replacements, frequently requiring additional crew and tackle. Besides these, as indicated in the adjoining chart, may be added repair-shop administration, minor construction, supervision of building and equipment contractors, and package making and repair.



As well as general supervision and acceptance of new plant classed as major construction

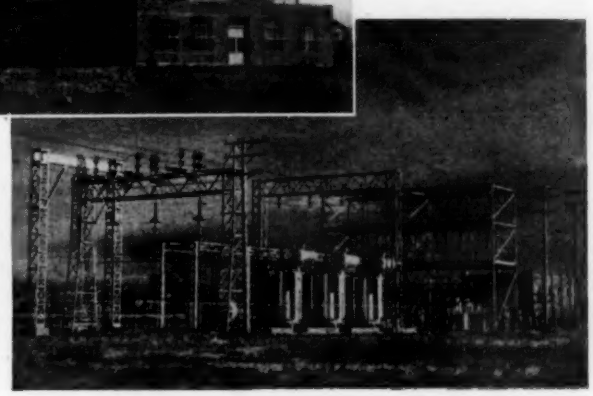
The servicing function is frequently the most difficult to separate from the process personnel. Oftentimes, among the process men are numbered those who have excellent mechanical skill and who prefer to do their own packing, oiling and adjusting. Moreover, they can demonstrate that they know more about these duties than most maintenance men. However, a carefully trained maintenance man who may be detailed to servicing duties in the plant should soon become more skilled and resourceful in this particular field than any process man to whom such work can be only incidental.

If the process department has taken on certain maintenance functions, this seeming appropriation may be traced back to occurrences normal in any plant. Perhaps the entire maintenance department was once drafted elsewhere onto an urgent job, while the process men did certain required maintenance work at no added cost, and it seemed expedient to continue the procedure. Vacations, or sickness, or accident may have made it advisable for the process men to take care of certain maintenance for a time, and the matter became a habit. A process foreman, eager for a better job, may have felt that the more tasks he could take on, the better his chances, and may have willingly accepted some of the duties of an overburdened maintenance department head. Such practices creep into plant routine almost unobserved and their weakness is revealed only by emergencies.

Power a Process Function

But if the process department tends to take on maintenance functions, this tendency is equalled only by that of the maintenance department to encroach on process work. This is particularly evident in the case of the power department.

Under the heading of "power," the chemical plant usually includes the production of steam, electricity, compressed air, and water, and the distribution systems for these essentials. Although these items are consumed by the various plant units, yet they are operating or process functions just as much as if they were intermediate



These functions, however, the operation of power house and purchased-power substation, are definitely operating department perquisites

▼

chemicals or chemicals sold to customers. Unfortunately, I think, for the maintenance department, it is usually found operating as well as maintaining the power department. This is the result of two conditions: the maintenance men, both supervisors and craftsmen, started their careers around the power house or made it their headquarters when the plant was small. Then, as the plant grew, quite naturally they absorbed the power function into their own department. Or, secondly, since power seemed unrelated to the production of chemicals, it became a sort of unwanted orphan, and the maintenance engineer, either because he was an especially obliging chap or because he wanted to "see the wheels go round" under his own supervision, willingly, but to the detriment of all concerned, took over the power house.

Production of steam assuredly is not a more complicated operation than the production of purified sulphur dioxide from pyrite; the treatment and pumping of water is not a whit more complicated than the regulation and pumping of sulphuric acid over an absorption tower; nor should the running of a turbine require a higher type of operative than the regulation of a mechanical muriatic plant. Since the power function is directly connected with the other plant processes and since it requires no more skilled attention than many chemical processes, its administration logically falls to the process department, thus relieving the maintenance department of a responsibility that always hampers its own proper function. It is axiomatic that the more time devoted to the maintenance planning and strategy, the lower will be maintenance costs.

Servicing—"Stitch in Time"

The service function of the maintenance department—routine inspection, oiling, and adjusting of plant machinery, is little less important than that of plant repairs. Properly carried out, it should forestall many large repairs that would otherwise bring about heartbreaking repair costs. For example, if a skilled electrician makes a daily inspection of each motor in the plant, checking its temperature, lubrication, the proper belt tension, its need of shop cleaning, the clearance, and the like, then he may reduce the chance of its burning out almost to the vanishing point. Moreover, he may prevent serious interruptions to production that would be far more costly than the rewinding of the motor.

Similar reasoning would apply to pumps. Careful periodic lubrication, repacking, and maintenance of clearance may increase the ordinary life of a pump several times and contribute to its efficiency considerably. Likewise, the regular cleaning of windows and electric lamps and shades undoubtedly has much to do with a full return on their cost. This servicing has little direct connection with the repairs, yet the men who perform this work best have the maintenance type of mind and makeup, rather than the process type.

But even maintenance men, as plant superintendents know, fall into two distinct classes. Both are indispensable, yet their full value can be obtained only when this difference between them is fully recognized. One type of maintenance man, the better craftsman, is irritated by the least deviation from perfect operation. For instance, should this type of man see a blower with bearings a trifle too warm or developing an ominous knock or rattle, he is for immediately shutting down the plant and rebuilding or replacing the blower, regardless of plant production. Mind you, this type of man is indispensable in doing high-grade repair work. The other type of maintenance man, and this is the sort who should be given the maintenance service job, finding the same blower, would by adjusting, oiling, or by his mysterious faculty for keeping things going, hold it to the job until everything else was set, so that disturbance to production would be cut to the minimum. The superintendent's maintenance policy will distinguish between these men.

Matching Jobs and Temperaments

Chemical plant superintendents recognize that first-class process men and first-class maintenance men differ fundamentally. Rarely does a very adept craftsman possess the temperament necessary to a good operator. The thorough-going process man must visualize the influences, often concurrent, of temperature, pressure, specific gravity, concentration, turbulence, and the like, upon the reactions of materials some of which may be unstable gases or compounds having only a theoretical existence. Aided by his control instruments, manometers, potentiometers, and indicators of various sorts, he instantly translates cause and effect in his materials into the necessary regulation of his plant.

In contrast, the maintenance man visualizes a machine as a substantial entity having precise dimensions, weights, conductivity, and the like. The fine mechanical perceptions of the high-grade craftsman differ not in degree but in kind from the intuitions of the skillful process man. Why men should be thus temperamentally different need not concern us here. We do know, however, that maintenance work of the chemical plant given to men fundamentally suited to it is reflected in minimum maintenance costs. Precisely the same reasoning holds for selecting process men.

In fine, the maintenance policy of a chemical plant might be summarized briefly thus:

1. The maintenance department is responsible for all repairs, replacements, and minor construction, for servicing of machinery and buildings, for the acceptance of new construction by contractors, for returnable package making and repair, and for repair shop administration.

2. The maintenance department is responsible for the maintenance of the power department in the same manner as for other process departments, but it shall not be responsible for power generation nor the operation of purchased-power equipment.

3. In selection of maintenance personnel, temperament and craftsmanship shall be given equal consideration.

National Safety Council, Chicago, has inaugurated, experimentally, a new service called "Safety Instruction Cards." These are 3x5-in. cards for distribution to operating executives, foremen and workmen, each one of which carries a technical or semi-technical treatment of a specific accident hazard. Since they are specific, it is felt that the subjects covered are unsuitable for poster treatment. Of the 14 cards at present available, several are of particular interest to chemical operating departments. Others should be valuable for maintenance distribution. A leaflet published by the Council gives complete information.

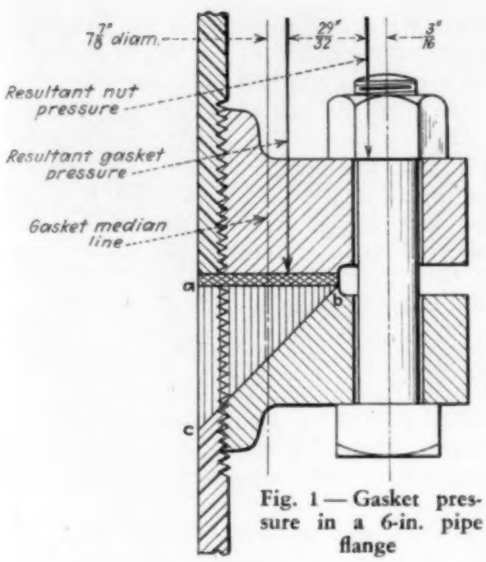


Fig. 1 — Gasket pressure in a 6-in. pipe flange

Bolts and Flanges for TANKS AND HEAT EXCHANGERS

By C. O. SANDSTROM
Thermal Engineering Co.
Los Angeles, Calif.

Editor's Note—In an earlier article (Dec., 1932, pp. 668-672) the author presented a general discussion of the design of heads for tanks and heat exchangers, with particular reference to the ordinary spherical dished head, and lesser attention to elliptical heads, flat, stayed heads and a plain spherical head without knuckle curve. In a later issue he will take up special heads and an improvement on the older ones.

AS WILL APPEAR from what follows, the design of bolts and flanges for attaching the heads of pressure vessels is far from a cut-and-dried business. Many assumptions are involved and designers are by no means in exact agreement as to procedure. As a first step, it is necessary to determine the total pressure acting on the head or cover. The one uncertainty in this step is the area under pressure. It is recommended by some authorities that this area be assumed as bounded by the outer circumference of the gasket. Although this errs on the side of safety I cannot agree with the recommendation. I think it best, or at least more workmanlike in engineering design, to establish the data to the best of one's ability and then allow for the unforeseen by so-called factors of safety. It seems obvious that the full fluid pressure cannot be exerted to the outside edge of the gasket. To say that it can implies that all but the outer edge of the gasket is useless in resisting the pressure—an evident absurdity. Tests may be made to determine the area under fluid pressure by drilling holes radially into the edge of the gasket and noting the depth at which leaks occur.

Whether the diagram of the fluid pressure on the gasket is a triangle with the apex at the outer edge of the gasket as shown in Fig. 1, or a parabola (or some other curve) with the vertex somewhere inside the edge, the total pressure, it seems to me, does not exceed the unit pressure times the area inscribed by the median line of the gasket for gaskets lying within the bolt circle which, for practical purposes, makes the pressure diagram the triangle *a, b, c,* shown in the figure.

Although the difference between the outside area and the median line area of gaskets in heat exchangers of large diameter may be a trifle, the difference in the case of some pipe flanges is large and would exert considerable influence on design, because of the comparatively large ratio of gasket area to port area. Having established the total fluid pressure, the next step is to find the additional pressure on the gasket necessary to insure tightness. The sum of the two is then the load carried by the flange and the bolts.

The pipe-flange bolting standards of the American Standards Association call for bolts which impose an apparent unit compression on the gasket of from 8 to 20 times the working pressure with full working pressure in the pipe (assuming that the compression is uniformly distributed, which it is not); the lower ratio being for raised face gaskets and the higher for the narrow tongue-and-groove gaskets.

Another question that has been much debated is the point of application of the pressure exerted by the nut on the flange. If this point is assumed to be on the circle passing through the centers of the bolts then the calculated results would certainly be on the safe side. It seems obvious, however, with a ring gasket lying entirely within the circle bounding the inside of the bolt holes, making a cantilever of the flange, that there is some deflection of the flange which, added to the deformation of the outer edge of the gasket, produces enough deflection to move the line of pressure to the inside half of the nut. It has been proposed to consider the line of pressure as acting on a circle tangent to the inside of the bolt holes, but this would introduce very high bending stresses in the bolts, which will be discussed later.

Uncertainties thus far disclosed are only added to when we come to proportion the bolts. When we consider that the efficiency of a bolt as a machine element lies between 10 and 20 per cent, dependent on the condition of the bearing surfaces and lubrication; and the uncertainty of the force applied to the wrench in tightening the nut, together with the uncertainties attending the area under fluid pressure, and the point of application of the tightening force on the flange, we are inclined to feel with Herbert Spencer that, "A definition of which the terms are indefinite, is an absurdity." Yet there is no other pro-

cedure that would give the work the status of engineering. Because a problem includes a number of indeterminates should not prevent its investigation with such means as we possess. We can usually define the limits and then design with safety, if not economy.

Many years ago tests were conducted at Cornell University to determine the stresses in bolts resulting from making steam-tight gasketed joints. Twelve experienced mechanics were allowed to select wrenches and screw up the nuts on three each of $\frac{1}{2}$-in., $\frac{3}{4}$-in., 1-in., and $1\frac{1}{2}$-in. bolts, simulating as nearly as possible the actual work on a steam-pipe flange or engine cylinder head. The test machine measured the loads produced and from these the stresses were computed. Naturally, the results were discordant, but they proved that very large stresses were produced by "the man with the wrench." The main conclusions from the tests were that $\frac{1}{2}$-in. bolts are inadequate for the service because they are frequently broken, and that the loads produced averaged about 16,000 lb. per inch of nominal diameter, or $W = 16{,}000D$ which, for a 1-in. bolt is a stress of $16{,}000/0.55 = 29{,}000$ lb. per square inch at the root of the thread.

A stress of 29,000 lb. per square inch in a material whose elastic limit is about 35,000 lb. seems like a high stress. In most cases it would be, but in the case of a flange bolt there is little likelihood of disaster because the leakage resulting from excessive stretch would be a warning that the bolts were inadequate, and the leakage, unless stopped, would soon "blow out" the gasket.

The tests at Cornell produced axial stresses in the bolts and for that reason the data are not directly applicable to the design of bolts for flanged joints with gaskets lying within the bolt circle. These bolts, as we have shown, are under transverse stress because of the eccentricity of the applied load. Furthermore, because of deflection of the flanges, the line of pressure of nut on flange is somewhere inside the bolt circle. We shall now attempt to find the transverse stress in the bolts of a pipe flange with a ring gasket lying within the bolt circle, using as some of the data the proposed pressure area and the proposed position of the resultant of the nut pressure; that is, the pressure acting over the entire area of the gasket, and the resultant nut pressure on the circle tangent to the inside of the bolt holes.

Finding Gasket Pressure

A 6-in. extra-heavy pipe flange for 250 lb. working steam pressure has an outside diameter of $12\frac{1}{2}$ in., a raised face $9\frac{11}{16}$ in. in diameter, a $10\frac{5}{8}$-in. bolt circle and has twelve $\frac{3}{4}$-in. bolts in $\frac{7}{8}$-in. holes. The customary gasket is $9\frac{3}{4}$ in. outside diameter. If we assume the steam pressure to be exerted over an area equal to the diameter of the face, we have a total pressure of $73.71 \times 250 =$ 18,430 lb. Assuming that the load is carried uniformly by the bolts (which is not quite true), each bolt would carry $18{,}430/12 = 1{,}536$ lb. of the direct steam pressure. If it be true that the flanges exert eight times the unit steam pressure over the face of the gasket merely to insure fluid tightness, then the load per bolt from this cause is $(73.71 - 28.27) \times 8 \times 250/12 = 7{,}573$ lb. The total load per bolt after tightening, and before the steam pressure is applied is, therefore, $1{,}536 + 7{,}573 = 9{,}109$ lb., and the direct tensile stress at the root of the thread of each bolt is $9{,}109/0.302 = 30{,}000$ lb. per square inch. If it also be true that the line of pressure of nut on flange is on a circle tangent to the inside of the bolt holes, then the eccentricity of the load is one-half the diameter of the hole, or $\frac{7}{16}$ in., assuming the bolt to be concentric with the hole. The bending moment is therefore $9{,}109 \times 0.4375 = 3{,}980$ in. lb. The section modulus of the area at the root of the thread of a $\frac{3}{4}$-in. bolt is $0.098 \times 0.62^3 = 0.0234$; so the extreme fiber stress at this section due to bending is $3{,}980/0.0234 = 170{,}000$ lb. per square inch which, added to the direct tensile stress of 30,000 lb., makes an extreme fiber stress in tension of 200,000 lb. per square inch. The elastic limit of the steel in these bolts is about 35,000 lb. and the ultimate strength about 65,000 lb. That these flanges and bolts are adequate for the service has been proved by many thousands of installations and many years of service, so it seems that there is something wrong with one or more of the assumptions.

In problems like the foregoing, with its multiplicity of uncertain factors, we must use successful practice as a guide. If, as I believe, the fluid pressure on the gasket

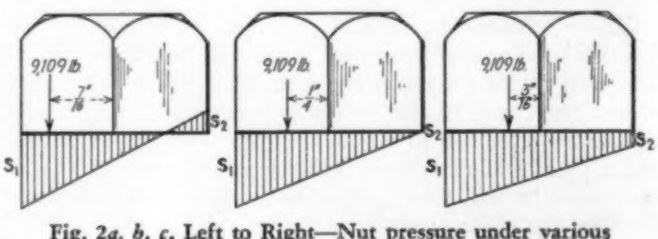


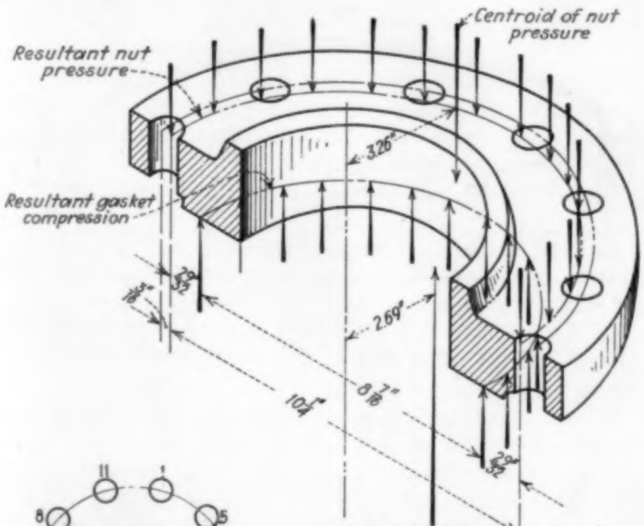
Fig. 2*a*, *b*, *c*, Left to Right—Nut pressure under various assumed conditions

does not exceed that represented by the triangle of Fig. 1, then the total fluid pressure in the foregoing example would be that over a circle of nearly $7\frac{7}{8}$ in. diameter or $48.7 \times 250 = 12{,}175$ lb. Before the nut is tightened up it has full bearing on the flange, and the pressure is as uniform as the accuracy of the machine work on flanges, nuts and threads allow. With the tightening of the nut comes a deflection of the flange and a deformation of the outer edge of the gasket which produces bending in the bolt. The consequence is that the pressure on the under side of the nut varies from a maximum at its inner edge to a minimum at its outer edge, the intensities varying according to the position of the resultant. If the resultant were on a circle tangent to the inside of the bolt holes, or $\frac{7}{16}$ in. from the center of the bolt, then there would be a negative pressure, at the outer edge of the nut, resulting in a tendency to separation of the nut and flange. The slight looseness of fit between nut and bolt, and the bending of the bolt, however, produce an accommodation that prevents actual separation at the outer edge of the nut, regardless of the position of the resultant. Fig. 2*a* shows the pressure variation across the face of the nut for the assumed condition.

Attempts to fix the exact position of the resultant of the nut pressure seem futile. That it does not coincide with the axis of the bolt is certain, as practice and reason agree. That it lies on the circle bounding the inside of the bolt holes is improbable because, as we have seen, of the very large bending moment so produced. Somewhere between the limits mentioned is the actual position of the resultant.

If the nut were regarded as a prism with an eccentric-

ally applied load that imposes a pressure varying from zero at its outer edge to a maximum at its inner edge, we probably would be nearer the truth. The position of the resultant for this case is obtained by dividing the section modulus of the bearing surface of the nut by its area. The section modulus of the bearing surface of a $\frac{3}{4}$-in. nut (a hexagon $1\frac{1}{4}$ in. across flats with a $\frac{7}{8}$-in. hole in the center) is 0.189, and its area is 0.752 sq.in. Dividing the former by the latter we have 0.251 in., which is the distance from the center of the bolt to the resultant of the bearing pressure and which is also the arm of the bending moment. The distance of the resultant from the center of any nut under the conditions described is very nearly the width of the nut across flats divided by five. Fig. 2*b* shows this pressure variation.



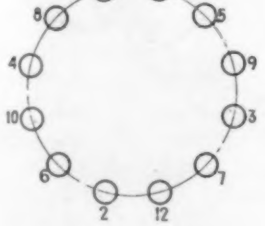


Fig. 3—Above: 6-in. flange under conditions of the problem

Fig. 4—Left: Proper sequence for bolt tightening

I cannot reconcile myself, however, to the belief that there is a state of zero pressure at the outer edge of the nut. Dismantled flanges bear evidence of pressure at that point by marks left in turning the nut, so it seems quite probable that the position of the resultant is between that just discussed and the center of the nut. If we select, as the position of the resultant, a point coinciding with one-half the radius of the bolt, I think we will be very near the true position. Any difference between this and the actual position is probably so slight as to have small influence on results. The pressure variation for this condition is shown in Fig. 2*c*.

If we assume, then, that the bolts in the 6-in. pipe flange discussed in the foregoing are just sufficient for the purpose; that the maximum fiber stress is one-half the elastic-limit of the steel, or 18,000 lb. per square inch; that the fluid pressure over the gasket is correctly represented by a triangle as shown in Fig. 1; and that the position of the resultant of the nut pressure is at one-half the radius of the bolt, or $\frac{3}{16}$ in., as illustrated in Fig. 2*c*, we can attempt to find the pressure between flange and gasket necessary to a fluid-tight joint.

The maximum fiber stress for the combined axial and bending loads in the $\frac{3}{4}$-in. bolt is found by the formula $f_s = P/A + M/S$, in which f_s is the extreme fiber stress in tension, or 18,000 lb. per square inch; P the force applied with eccentricity of 0.1875 in.; M the bending moment, 0.1875 P; S the section modulus at the root of the thread, or $0.098 \times 0.62^3 = 0.0234$; and A is the area of the bolt at the root of the thread, or 0.302 sq.in. The equation then becomes $18{,}000 = P/0.302 + 0.1875\ P/0.0234$, and P for one bolt = 1,590 lb. For 12 bolts P = 19,100 lb.

The area under fluid pressure (that is, the area of the $7\frac{7}{8}$-in. circle assumed under full fluid pressure) is 48.7 sq. in., and the total pressure is $250 \times 48.7 = 12{,}175$ lb. which, subtracted from the 19,100 lb., leaves 6,925 lb. for the apparent gasket compression. The area of the gasket face is $73.7 - 28.27 = 45.43$ sq.in., and if the gasket compression is distributed uniformly over this area, the unit pressure is $6{,}925/45.43 = 152.5$ lb. per square inch, or considerably less than the unit working pressure. At the elastic limit of the bolt, the unit gasket compression is nearly 550 lb. per square inch, or a little more than twice the unit working pressure.

Uniformity of distribution of the gasket compression depends on the rigidity of the flange and, in the case of a flange integral with the pipe, the rigidity of both. With the resultant pressure of the nut applied 0.1875 in. inside the bolt circle of $10\frac{5}{8}$ in. diameter; and the median line of the gasket face a circle of $7\frac{7}{8}$ in. diameter, the application of the force is $(10\frac{1}{4} - 7\frac{7}{8})/2 = 1.1875$ in. from the median line as shown in Fig. 1.

If the resultant of the gasket compression were taken as at the outside of the middle third of the gasket I think we would be near the truth. The line of the gasket compression would then be a circle of $9\frac{11}{16} - (2 \times \frac{5}{8}) = 8\frac{7}{16}$ in. diameter. The line of the resultant of the nut pressure is a circle of $10\frac{5}{8} - (2 \times 0.1875) = 10\frac{1}{4}$ in. diameter. The difference in the diameters of these two circles is a measure of the bending moment in the flange.

Calculating Flange Thickness

In Fig. 3 is a diagrammatic outline of one-half of the 6-in. pipe flange under discussion. The distances of the centroids from the diameter of the semi-circular arcs, representing the gasket compression and the nut pressure, are Dia./π or 2.69 in., and 3.26 in., respectively. The magnitude of each of these two pressures is equal to one-half the total pressure of all the nuts, or $6 \times 1{,}590 = 9{,}540$ lb. The bending moment in the flange is, therefore, the moment of the total nut pressure minus the moment of the total gasket compression about the selected diameter, or $9{,}540\ (3.26 - 2.69) = 5{,}440$ in.lb. With an allowable fiber stress for cast iron of 3,000 lb. per square inch, the required section modulus is $5{,}440/3{,}000 = 1.81$. The net width of the flange through two opposite bolt holes is $12.5 - 6.625 - 2 \times 0.875 = 4.125$ in. The required thickness of the flange, assuming it to be without a hub, is $t = \sqrt{1.81 \times 6/4.125} = 1.62$ in. The actual thickness of the flange in this case is 1.4375 in., with a hub 2 in. high measured from the face of the flange, which hub adds considerably to the strength and compensates for any real want of thickness of the flange.

Just what is the best width of gasket for the flanges

of any pressure vessel probably has never been determined. Because of the many indeterminate factors involved in the design, this question is difficult to answer. The primary purpose of a gasket is to fill up inequalities and irregularities in the face of the flange. Gaskets are composed of rubber, paper, canvas or duck, lead, copper, soft steel and mixtures or compositions of these and other materials. Each material has its best field but the limits are not rigidly defined. One must, however, avoid using a material that is damaged by high temperature or by the solvent action of the fluid. Since gaskets are thin, there need be no fear of squeezing the gasket out of the flanges except in cases of narrow gaskets. (An experimental check of this statement may be made by squeezing a piece of $\frac{1}{16}$-in. soft rubber gasket between the jaws of a machinist's vise.) A satisfactory width of gasket for a raised face flange is 1 per cent of the inside diameter plus 1 in.; and for a tongue-and-groove flange, 1 per cent of the inside diameter plus 0.5 in. Gaskets of copper wire or steel rings, wedged into grooves, are sometimes used, but cannot be discussed here for the want of space.

Tightening Flange Bolts

Nearly equaling the gasket in importance is the method of tightening the flange bolts. While almost any gasket can be made tight if the bolts are properly applied, neglect often causes failure. The ideal method of applying flange bolts is to tighten them all at once which, of course, is impracticable, but the method that most nearly approaches this is the bolt-tightening sequence of Fig. 4 which will be successful if the nuts are brought up a little at a time; that is, in several operations. The numbers in the figure show the order in which the bolts are tightened, care being taken that the nuts of all bolts are screwed up as uniformly as possible.

We shall now design the head shown in Figs. 5 and 6 which is of the kind used on absorption towers and heat exchangers. The following are the data: D is the diameter of the shell, or 48 in.; L the radius of the head, also 48 in.; P the working pressure, or 250 lb. per square inch; T the ultimate strength of the steel, or 55,000 lb. per square inch; t the thickness of the head (see the author's earlier article), or $8.33PL/2T = 8.33 \times 250 \times 48/2 \times 55.000 = 0.91$ in., say $\frac{15}{16}$ in. Width of gasket is $1 + (50 \times 0.01) = 1.5$ in. The pressure under the head is $50^2\pi 250/4 = 490.900$ lb., and is transmitted to the bolting flange on a resultant circle of 49 in. diameter. The fluid pressure under the flange is assumed to vary from zero at the outer circumference to 250 lb. per square inch at the inner circumference of the gasket, making the average 125 lb. over the area of the gasket, or a total of $125\ (2206.2 - 1963.5) = 30{,}340$ lb. Since the pressure diagram is a triangle, the resultant pressure is at one-third the width of the gasket from its inner circumference, so the resultant circle in this case is 51 in. diameter. The final gasket pressure (that is, the pressure assumed as necessary for fluid-tightness) is 250 lb. per square inch over the area of the gasket, or $250\ (2206.2 - 1963.5) = 60{,}680$ lb., which is applied on a resultant circle of 52 in. diameter. The total force to be resisted by the bolts is the sum of the three just found, or 581,920 lb.

As a first step in the selection of the bolts, choose what appears to be a reasonable spacing, say 3 to 4 in. in this case 3.5 in. The bolts must lie outside of the gasket of 1.5-in. width and 53 in. outside diameter, so we shall assume a bolt circle of 54.5 in. diameter. The number of bolts is then $54.5\ \pi/3.5 = 49$ or, say, 50 bolts. Dividing the total pressure on the gasket by this number we have $581{,}920/50 = 11{,}640$ lb. as the pressure exerted by each nut on the resultant-pressure circle.

The next step is to determine the size of the bolts. Using Class A, heat-treated bolts and an extreme fiber stress of one-half the elastic-limit or 35,000 lb. per square inch, the equation for the combined stress is $35{,}000 = 11{,}640/0.7854\ d^2 + 11{,}640 \times 1.15\ d/4 \times 0.098\ d^3$, in which d is the diameter of the bolt at the root of the

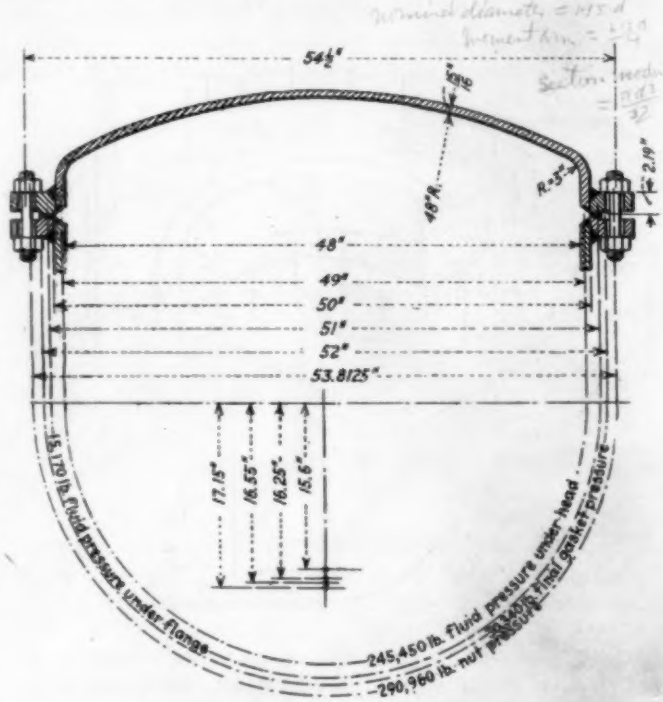


Fig. 5—Spherical head of the problem, showing pressure resultants and centroids

thread. As the eccentricity of the load was assumed as the nominal diameter of the bolt divided by four, the expression for the approximate nominal diameter was obtained by multiplying the diameter at the root of the thread by 1.15 which is close enough for practical purposes and which simplifies the work. Solving for d we have $d = \sqrt{49{,}000/35{,}000} = 1.18$ in. The nearest bolt size is $1\frac{3}{8}$ in., which is 1.16 in. at the root of the thread.

That the elastic limit of bolt material is frequently exceeded, especially in the smaller sizes, is certain. But to produce this condition with an axial force in a Class A, heat-treated bolt of $1\frac{3}{8}$ in. diameter, would require an extension on the handle of the wrench. The product of the theoretical force and the length of wrench to produce a stress of 70,000 lb. per square inch in a $1\frac{3}{8}$-in. bolt is $FL = 70{,}000A/2\pi\ n$, in which F is the force applied to the wrench; L the length of the wrench; A the area of the bolt at the root of the thread; and n the number of threads per inch. Solving, $FL = 70{,}000 \times 1.057/2 \times 6\ \pi = 1{,}960$ in.lb. But the efficiency of a bolt in the transmission of power is very low. Wilfred Lewis proposed the formula $1/(1 + nd)$ for the efficiency, in

which d is the nominal diameter. Applied to the theoretical value found above, we have 1,960 $(1+6\times 1.375) = 18{,}100$ in.lb. A strong man in a convenient position can apply a force of 250 lb. to the end of a wrench which, represented by F in the formula, calls for a length L of 72.5 in.

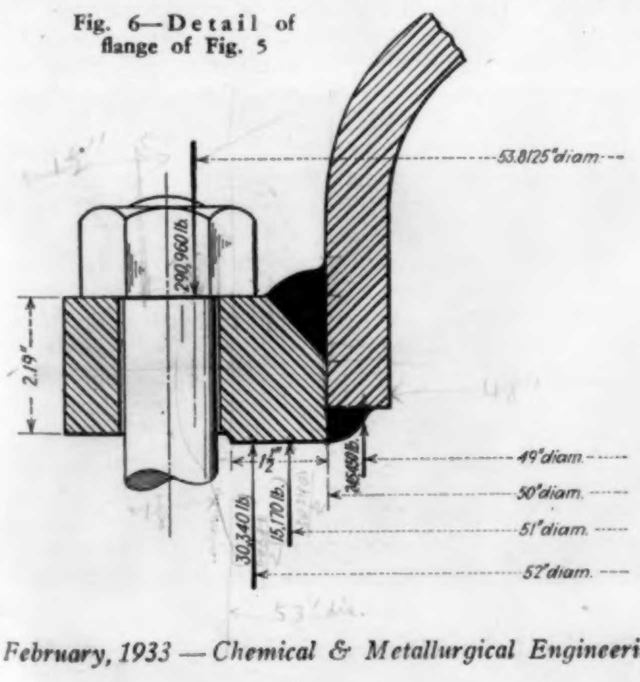
In the case of flange bolts subjected to the eccentric load discussed in the foregoing, the product FL is much less than found for axial loading. Substituting the allowable load of 11,640 lb. per bolt for the expression $70{,}000A$ in the foregoing formulas, the product of FL becomes 2,860 in.lb., and the length of wrench 11.5 in. with a force of 250 lb. to develop the working strength of the bolt. The elastic limit would be reached with a length of 23 in. *Eccentric loading explains many seeming defects of bolt material.*

The width of the bolting flange should be sufficient to give full bearing to the nut which, for a 1⅜-in. bolt is a minimum of 1¼ in. from center of hole to edge of flange. For the sake of appearance, however, the flange should be a little wider than the nut. In the present case the flange is 3¾ in. wide, and the distance from the center of the hole to the outer circumference of the flange is 1½ in.

As shown in Fig. 5, the bolt circle is 54.5 in. diameter. The circle on which the resultant nut pressure is exerted is $54.5 - 2(1\frac{3}{8}/4) \fallingdotseq 53.8125$ in. diameter. The resultant of the gasket compression was found to be on a circle 52 in. in diameter. The head may be regarded as resting on the nuts on the 53.8125-in. circle, while the initial gasket compression may be regarded as a load concentrated on the 52-in. circle. Before the fluid pressure is applied to the head, the pressure of the nuts is resisted entirely by the gasket reaction, that is, by the initial gasket compression. Upon application of the fluid pressure, the initial gasket compression is relieved by the fluid pressure over the area subjected thereto, and the remaining gasket compression is that necessary to insure tightness, plus any excess due to overstressing the bolts.

Referring to Fig. 6 we can find the positions of the several resultants. The total pressure found in the foregoing is divided by two to get the pressures on each half of the cover, resulting in 245,450 lb. for the fluid pressure under the head; 15,170 lb. for the fluid pressure under the flange; 30,340 lb. for the final gasket pressure; and the sum of these, or 290,960 lb. for the load carried by the bolts.

Fig. 6—Detail of flange of Fig. 5



The kind of head discussed is unlike a flat head in that the load is carried to the bolting flange through the flanged perimeter of the head. Referring to the lower part of Fig. 5 we note that the centroid of the semicircle representing the fluid pressure under the head is $49/\pi = 15.6$ in.; the centroid of the fluid pressure under the flange is $51/\pi = 16.23$ in.; the centroid of the final gasket pressure is $52/\pi = 16.55$ in.; and the centroid of the resultant nut pressure is $53.8125/\pi = 17.15$ in. from the diameter.

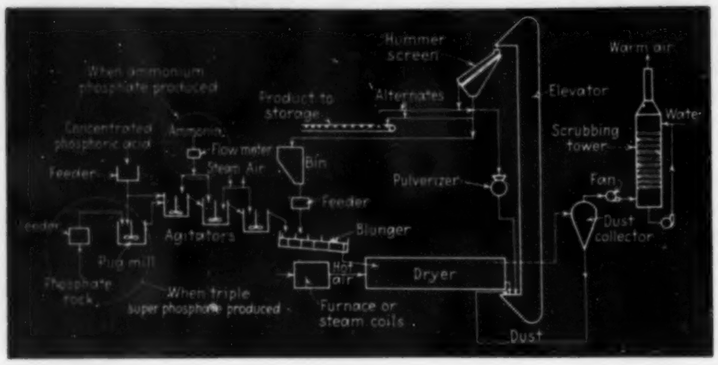
Taking moments about a diameter, the moment of the resultant nut pressure is $290{,}960 \times 17.15 = 4{,}990{,}000$ in.lb. ; the moment of the final gasket pressure is $30{,}340 \times 16.55 = 502{,}500$ in.lb.; the moment of the fluid pressure under the flange is $15{,}170 \times 16.23 = 246{,}000$ in.lb.; and the moment of the pressure under the head is $245{,}450 \times 15.6 = 3{,}830{,}000$ in.lb. Subtracting the sum of the last three from the first we have $4{,}990{,}000 - 4{,}578{,}500 = 411{,}500$ in. lb. as the bending moment on a diameter of the head. The required section modulus, with an allowable fiber stress of 11,000 lb. per square inch, is $411{,}500/11{,}000 = 37.4$ cu.in.

Determining Weld Depth

There need never be any concern about the resistance of the head about a diameter. The critical, or dangerous, section, in a head of this kind is along the weld joining the head and the bolting flange. A method of finding the depth of the weld, or the thickness of the flange, is to take moments about the joint, regarding the flange as a cantilever whose length is the semi-circumference, in this case $50\,\pi/2 = 78.54$ in. The resultant nut pressure was found to be 290,960 lb., and its moment arm $(53.8125 - 50)/2 = 1.9063$ in., and the bending moment $290{,}960 \times 1.9063 = 555{,}000$ in.lb. Opposing this is the moment of the fluid pressure on the flange, or $15{,}170 \times 0.5 = 7{,}585$ in.lb., and the moment of the final gasket pressure, or $30{,}340 \times 1 = 30{,}340$ in.lb. Subtracting the last two from the first we have 517,075 in.lb. to be resisted by the flange weld. With an allowable fiber stress of 11,000 lb. per square inch and a weld efficiency of 75 per cent, the required section modulus is $517{,}075/11{,}000 \times 0.75 = 62.7$ cu.in. and the required thickness, $t = \sqrt{62.7 \times 6/78.54} = 2.19$ in.

When the flange is not integral with the cover, or is not welded thereto, as for example a loose-ring flange of the Van Stone type, it would not receive the assistance of the cover in resisting the transverse stress on the diameter, consequently it would be of comparatively huge proportions. The method of design discussed in connection with Fig. 3 would then apply. The bending moment about the diameter was 411,500 in.lb., and the required section-modulus was 37.4 cu.in., and for one side of the ring is one-half this or 18.7 cu.in. Deducting a 1.5 in. hole from the 4-in. width of flange, the net width is 2.5 in. The required thickness of the flange is, therefore, $t = \sqrt{6 \times 18.7/2.5} = 6.7$ in.

Correction: Through error the captions for Figs. 7 and 8 in Mr. Sandstrom's earlier article in December, 1932, are incorrectly given. While Fig. 6 is semi-elliptical, Figs. 7 and 8 represent spherical, dished heads.



Flow diagram of Trail's two principal fertilizer processes

By WILLIAM C. WEBER
Chemical Engineer
The Dorr Co., Inc., New York City

MAKING PHOSPHATE FERTILIZERS AT TRAIL

IN A RECENT ARTICLE (December, 1932, pp. 659–662) the writer described the new plant built by the Consolidated Mining & Smelting Co., of Canada, Ltd., at Trail, B. C., for the wet-process production of phosphoric acid of 30–32 per cent P_2O_5. As was pointed out there, conventional plants employing the weak-acid process have turned out a product of 20–22 per cent P_2O_5 content which, if it were used in the new, simplified fertilizer processes in operation at Trail, would require the evaporation of 250 to 310 tons of water per day in concentrating the acid to 34–37 per cent P_2O_5. By the use of the strong-acid process (which, together with the fertilizer processes to be described was developed jointly by the Dorr Co., Inc., and its affiliate, Kunstunger Patent Verwertungs A. G.) the necessary evaporation is reduced to 60–90 tons of water per day, permitting the use of an inexpensive evaporator installation operated on surplus byproduct steam.

The fertilizer processes, which are the subject of the present article, may be briefly described as follows: In the case of mono-ammonium phosphate, strong phosphoric acid (34 to 37 per cent P_2O_5) is saturated continuously with gaseous, anhydrous ammonia in agitators. The resulting slurry is mixed with recirculated finished product in a blunger which discharges the mixed and nodulized mass into a rotary dryer. The dried product is elevated to vibrating screens. The +24 mesh material, which is also substantially —10 mesh, is sent to storage. The fines are returned to the blunger. The oversize may or may not be ground as required to maintain the desired size of circulating product for best nodulization. Fines produced in the dryer are recovered in dust collectors and returned to the circuit to be built up into coarse nodules.

The product obtained in this way is substantially mono-ammonium phosphate. If a lower $P_2O_5:N_2$ ratio is desired, a mixture of sulphuric and weaker phosphoric acid is used. A product has been produced in this way with about 60 per cent ammonium sulphate having the minimum analysis 20 per cent NH_3 and 20 per cent P_2O_5.

In making triple superphosphate, the strong phosphoric acid, concentrated to a P_2O_5 content of 39 per cent in single-stage vacuum evaporators and mixed with —80 mesh, dry, ground phosphate rock, flows continuously through three reaction agitators. The resulting slurry is mixed with recirculated, finished product in a blunger and dried in a rotary dryer. The dried product is elevated to a pair of vibrating screens. The —6 mesh undersize from one of these screens goes to the finished-product storage, the undersize of the other to the "fines" bin serving the blunger, and the oversizes of both screens go to hammer mills in closed circuit with the screens.

A feature of these processes in their interchangeability which with uncertain markets is a great advantage. It will be seen that the flowsheets and equipment for producing either triple-super or ammonium phosphate are almost identical. Two of the three units are so equipped that they may be used for either product. It is therefore possible to produce at will a series of compounds varying from triple-super, 46 per cent P_2O_5—0 per cent N_2, to ammonium phosphates with 11 to 16 per cent N_2 and 52 to 20 per cent P_2O_5.

This brief summary will assist the reader in following the detailed description of fertilizer manufacture which follows. The three section basis employed in the phosphoric acid plant is carried through the fertilizer section with two sections equipped to produce either ammonium phosphate or triple superphosphate and the third only ammonium phosphate. At rated capacity the output of the three ammonium phosphate sections is 260 tons per day and the product contains a minimum of 50 per cent P_2O_5, 11.5 per cent N_2, 4.0 per cent SO_4 and 1.0 per cent moisture. Into its manufacture go 450 tons of phosphate rock and 37 tons of anhydrous ammonia at

an approximate overall conversion efficiency of 91 to 93 per cent of the P_2O_5 and 99 per cent of the N_2.

The two triple superphosphate sections have a combined rated capacity of 276 tons per day and the product contains a minimum of 45 per cent P_2O_5 total or 43 per cent available. At this rate of output 300 tons per day of primary rock and 120 tons of secondary rock containing 32 per cent P_2O_5 and 44 per cent CaO are used and the overall recovery of P_2O_5 is about 94 per cent.

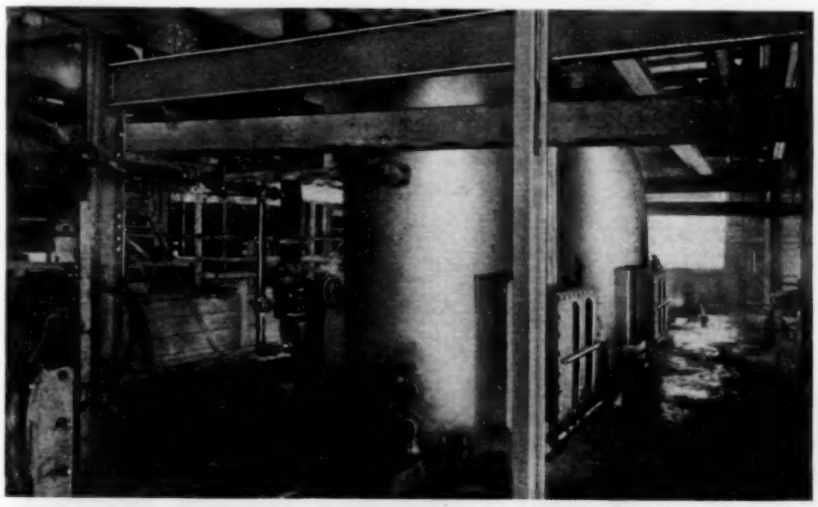
For ammonium phosphate an acid with about 34 to 37 per cent P_2O_5 is preferable for optimum nodulization and capacity. For triple superphosphate 39 per cent P_2O_5 is required with Montana rock. The 30–32 per cent acid from the filters must therefore be evaporated somewhat depending on the product produced.

Four 5-ft. diameter, single-effect Swenson vacuum evaporators are used, one for each section, and one as a spare. These are provided with cast-lead catchalls and barometric jet condensers. Bodies are of cast lead, tube sheets of hard lead and tubes of copper, specially lead covered. The concentrated acid overflows the evaporator through a barometric leg to a sump. It is there mixed with the 30–32 per cent acid from the filters and pumped continuously to storage tanks provided with light thickener mechanisms. Concentrated acid is drawn from the bottom together with any precipitated solids to further processing.

Scaling of tubes, body, condenser and vapor piping has always been a great source of grief in phosphoric acid evaporation and has caused users to go to very expensive and less efficient types of evaporators to avoid this trouble. P_2O_5 entrainment losses have also always been considered a necessary evil when concentrating phosphoric acid. By the novel method of continuous circulation which was developed at this plant these difficulties have been almost entirely eliminated and maintenance and lost time greatly reduced. Vacuum evaporators may, therefore, be said now to be thoroughly satisfactory for phosphoric acid.

In the manufacture of ammonium phosphate the concentrated acid flows from the storage tank to a Howard acid feeder which delivers it in a continuous stream to the first of three, series-connected, propeller agitators 8 ft. in diameter by 8 ft. deep. Into this first agitator 90 per cent of the ammonia is introduced in gaseous form at 7 lb. pressure through two stainless-steel pipes. The remaining 10 per cent of the ammonia required for neutralization and control is added in the same way to the second agitator. Cooling of the resulting slurry takes place in the third agitator. Violent boiling occurs in the first two agitators, but with neutralization to a pH of 4.5 (mono-ammonium phosphate) ammonia loss with the steam which is carried away by an exhaust fan is negligible.

Swenson evaporators for producing strong phosphoric acid
Propellor-type agitators for primary fertilizer reactions



Liquid ammonia is stored just outside the fertilizer plant in an insulated Horton sphere. Equipment for liquefaction and evaporation has been installed so that the entire production may be stored in the liquefied state and converted to the gaseous form is needed.

The slurry formed in the reaction overflows into a heavy mixer or blunger. This consists of a pair of very heavy and rugged shafts with angular, overlapping blades, set parallel to each other in an inclined steel tank set at a slope of 1½ in. per foot. The shafts are geared together and operate in opposite directions so that the overlapping paddles on both shafts move upward together along the center line and downward along the sides of the tank.

A large amount of dried and finished product in the form of pellets or nodules is continuously added to the blunger from an overhead bin with chute feeder. The blunging action effectively coats the recirculated pellets with a thin film of slurry, an ideal condition for efficient and rapid drying. The blunger discharges its product through an opening at the lower end and down a steep chute into the feed end of a rotary, direct-heat dryer, 8 ft. in diameter by 60 ft. long. Two dryers are provided with chain-grate stokers for burning slack coal and the third utilizes steam at 125 lb. pressure. The products of combustion travel concurrently with

the product. A maximum outlet temperature of 130 deg. C. is avoided because of the danger of decomposing the mono-ammonium phosphate. Discharge temperature is kept at from 70-75 deg. C., at which point optimum operation is obtained. The dried product drops through a 2-in. grizzly and is elevated to the screens.

Gases from the dryer pass through a Raymond dust-collecting system and a large paddle-wheel fan with a capacity of 28,000 cu.ft. per minute at a suction of 10 in. of water. The system consists of four primary cones, discharging by means of a small fan into a single collecting cone. The discharge from the collecting cone passes back into the inlet to the primary cones. These collectors are extremely efficient and dust losses are negligible. Collected solids are discharged through automatic valves. Fan discharge goes to a 10-ft. x 40-ft. packed scrubbing tower where all of the dust and about 85 per cent of the fluorine is removed. Towers and packing are of wood, impregnated with creosote. Scrubber water is recirculated and returned to the system.

Dryer discharge is lifted to the screens by means of bucket elevators which are of the double-chain type with manganese-steel links and sprockets. Especially heavy construction is employed so that reliable operation may be assured even at capacities as high as 2,500 tons per day. Each elevator delivers to two duplex Hummer vibrating screens. One surface is equipped with a 10-mesh screen and the other with a 24-mesh screen. The +10-mesh material goes to a Sturtevant swing-hammer mill which operates in closed circuit with the screen via the bucket elevator. The +24-mesh material is the finished fertilizer. It is substantially —10 mesh and well nodulized. It is carried by a long belt conveyor to the storage and shipping plant. This conveyor is provided with an automatic weigh hopper and continuous sampler for accurate check of the output. The fines from the screens drop into a small bin above the blunger.

Two identical sections are laid out for the manufacture of triple superphosphate, but are arranged so that they may easily be used for making mono-ammonium phosphate. Some of the same dried phosphate rock that is used in the acid sections is ground dry in an air-swept 8-ft. Hardinge mill, set to deliver a —80-mesh or —150-mesh product. The grinding to —150 mesh seems to be justified in the case of the rock from Montana, since grinding to this fineness reduces the citrate-insoluble which is unavailable in the finished product. The ground product is delivered by a Fuller-Kinyon dust pump to separate compartments of the catenary bin.

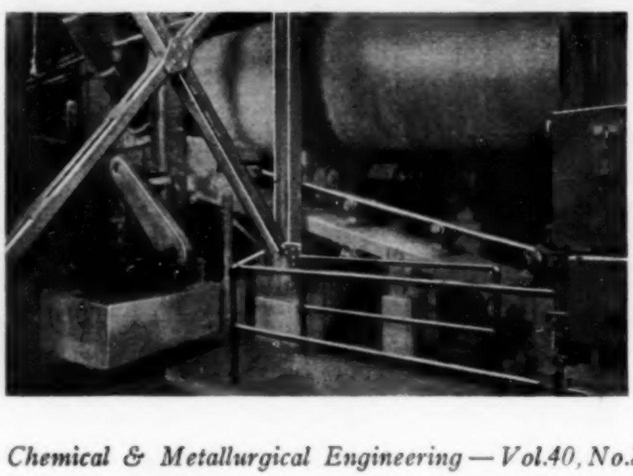
Ground rock and phosphoric acid are delivered to a "pug mill" continuously and in measured amounts by a Schaffer Poidometer and a Howard acid feeder. The so-called "pug mill" is simply a small tank, 3 ft. square and 4 ft. deep, provided with a high-speed propeller. The slurry discharged by the "pug mill" gravitates through three series-connected, reaction agitators 8 ft. in diameter by 8 ft. deep. The tanks are of wood, lined first with lead and then with brick, and the propellers and shafts are of alloy steel. The desired temperature and fluidity of the slurry is obtained from the exothermic heat of reaction, corrected by admitting either air or steam through alloy-steel pipes, depending to some extent on capacity.

The slurry is continuously removed from the second or third agitator by diaphragm pumps and delivered to a mixer or blunger as described for ammonium phosphate. In fact, except for screen sizes, the remainder of the plant is the same as the ammonium-phosphate plant —drying, dust collection, screening and fines recirculation. Whereas in the ammonium-phosphate sections the screens are 10 mesh and 24 mesh, in the triple-super sections they are ½-in., $\frac{3}{16}$-in. and 6 mesh. Oversize from all three screens is crushed in 36-in. Jeffrey hammer mills. Minus 6-mesh product goes to finished product storage and the minus ½-in. and $\frac{3}{16}$-in. material goes to the fines bin and re-enters the drying circuit with the new slurry at the blunger. The different sizes of screen sections are used to control the size of circulated nodules. Because of the nodulizing effect obtained with heavy circulation, the —6-mesh product is substantially +14 mesh and practically dustless. It is carried by a long conveyor paralleling that for ammonium phosphate to the storage and shipping plant.

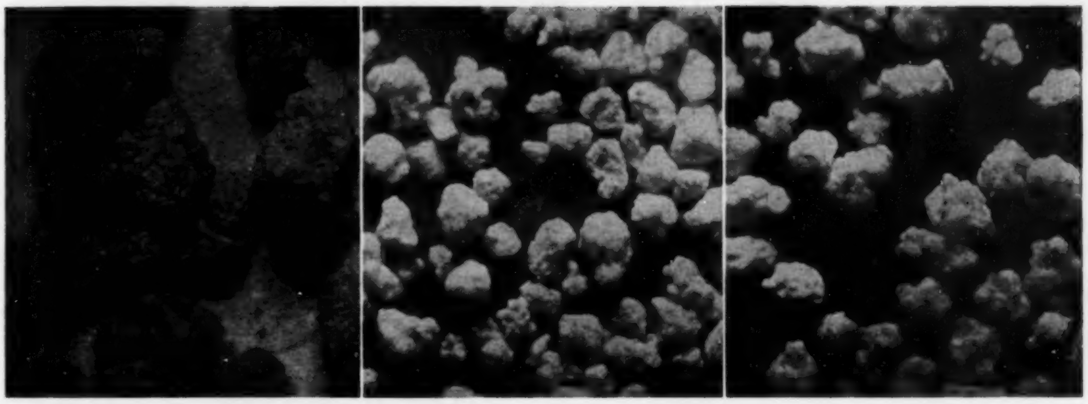
Reviewing the process, it will be remembered that three primary products are made—phosphoric acid, ammonium phosphate and triple superphosphate. The phosphoric acid is reprocessed to produce the other two. Ammonium sulphate is made in a separate plant not described in this article. For direct use, all products are shipped in 100-lb. double paper-lined bags. They are also shipped in bulk to fertilizer mixers. The ammonium phosphate is approximately —10 +24 mesh, non-caking and free-flowing. The triple superphosphate is —10 mesh, non-caking and excellently conditioned.

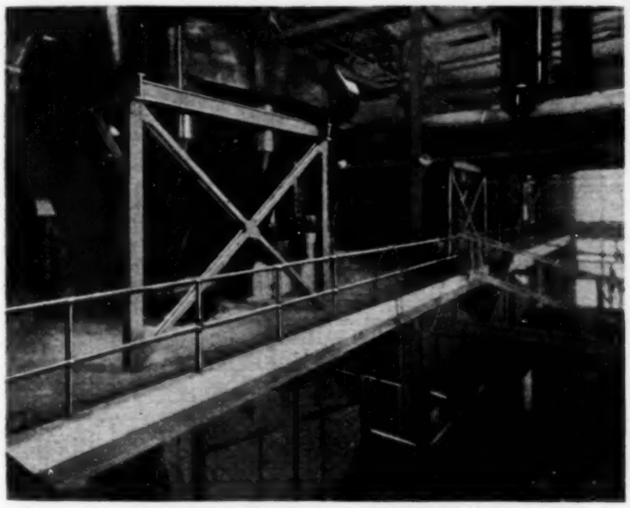
A feature of the fertilizer processes is the production of more or less nodular, closely-sized products. Where concentrated fertilizers are produced for direct

Blunger for mixing reaction and recirculated product
Feed end of 8-ft. x 60-ft. hot-air dryer



Photomicrographs × 8 of fertilizer products: Left to right, triple superphosphate, mono-ammonium phosphate and ammonium sulphate-phosphate





Raymond cyclone collectors recover dust from dryers

application, the specification of an ideal product would probably read as follows:

1. Nonhygroscopic at ordinary humidities; minimum of exposed surface.
2. Non-caking in storage; spherical, smooth particles.
3. Free flowing; spherical, smooth, closely-sized particles.
4. Maximum particle size about 10 mesh, permitting good distribution; dust and fines free.

In the accompanying photomicrographs of the products produced at Trail (magnification 8 ×), it will be seen that the diameter of particles does not show a variation of more than 2:1 from maximum to minimum. The triple superphosphate is substantially —6 mesh +14 mesh; the mono-ammonium phosphate substantially —10 mesh +20 mesh; and the ammonium sulphate-phosphate substantially —9 mesh +16 mesh.

The ammonium phosphates are practically ideal products chemically and physically. The superphosphate is too coarse and does not nodulize as well. The production of a substantially spherical particle of uniform size is a function of the finished product circulation process used. Only the desired size need be split off to production and the remainder returned for correction. Circulation ratios of from 200 per cent in the case of ammonium sulphate-phosphate to 1,500 per cent in the case of triple superphosphate are used. This means that the average particle passes through the blunger-dryer circuit that many times. Each pass is equivalent to dipping the particle in slurry and then crystallizing new material on the surface in the dryer. Rough edges and loose crystals are knocked off to act as new nodule nuclei. The precipitated impurities in the acid, such as iron and aluminum phosphates and dicalcium phosphate, act as binders to hold the crystals together. Therefore, what has often been referred to as a troublesome impurity in phosphoric acid by the wet process becomes an actual asset.

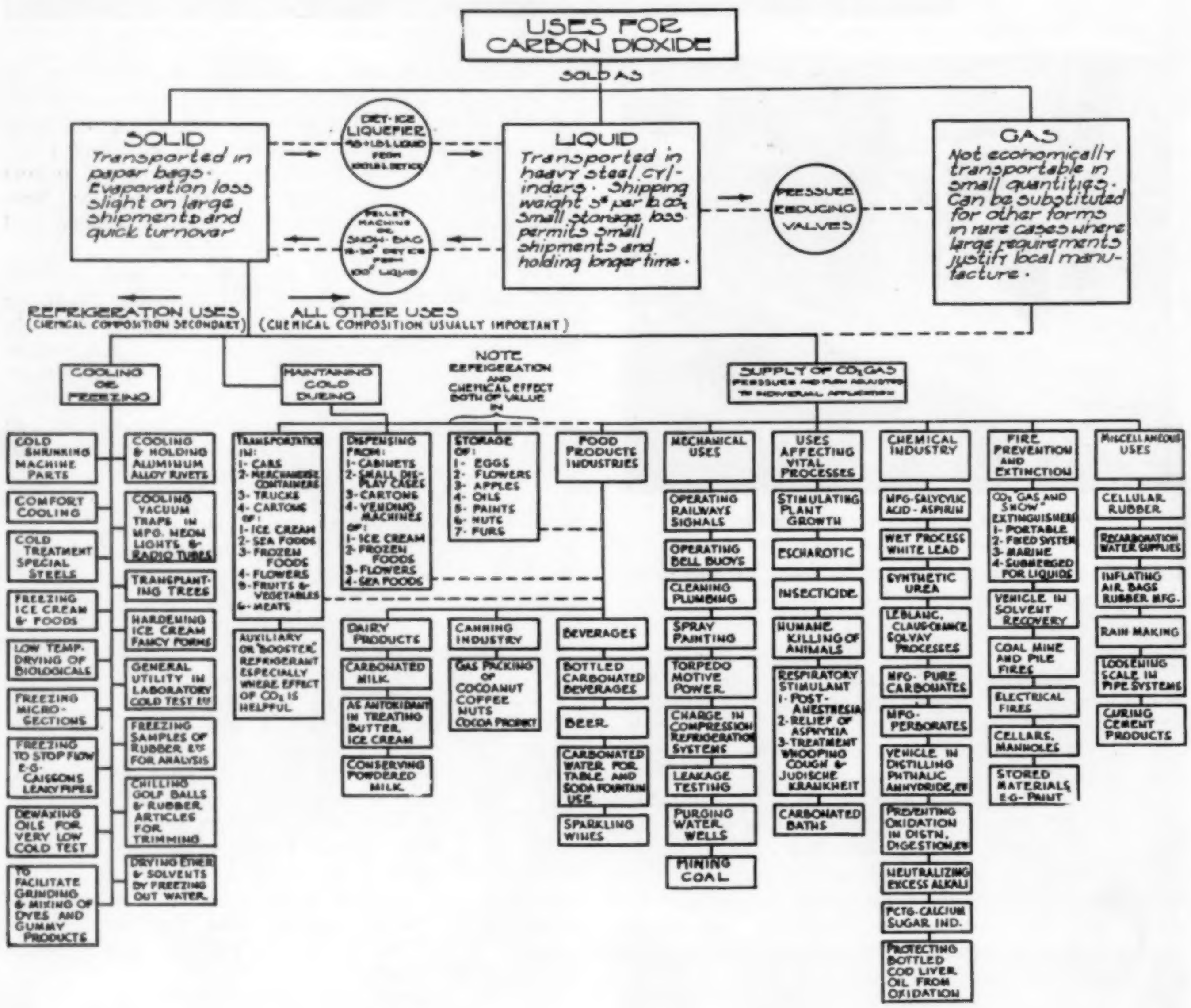
The first section of the combined acid and fertilizer plant was started up early in 1931, with the remaining sections starting later in the year. Operation was established on a reliable, continuous basis about six months later and the supervisory staff was gradually withdrawn before the end of the year. The plant was constructed to treat 150 tons of rock per section per day and to produce from the resulting phosphoric acid either mono-ammonium phosphate or triple superphosphate with a P_2O_5 recovery of not less than 91 per cent. In actual practice somewhat better than this capacity has been secured, while the overall extraction and utilization of the P_2O_5 in the rock has also been gratifying. Unaccounted for losses, other than in the waste gypsum and dryer gases, can be held under 0.5 per cent.

A careful and elaborate system of chemical control is used. All monthly inventory and raw material and product analyses are made by a central assay office. On the other hand, daily inventories and hourly and shift samples for operating control purposes are made in a laboratory located on the operating floor of the phosphoric acid plant. A chemist, benchman and sample boy are provided on each shift. Results are posted immediately on a large control board outside the operating office. Each shift is in charge of a shift boss. The phosphoric and fertilizer sections are separate and each in charge of a chief operator who, together with his assistant, is responsible for the chemical and technical control of the processes.

The supervisory organization consists of a works superintendent, assistant superintendent, chief chemist, chief mechanic, instrument and plant testing engineer and clerk. A large number of recording thermometers are located at strategic points and integrating flowmeters are provided for steam and ammonia. Unusual care has been taken to provide plenty of operating space, permanent structures of steel and concrete, and rugged equipment which is a credit to the operators and the management. By a judicious system of employment and training, an unusually good operating crew has been developed.

Carbon Dioxide in Industry

By CHAS. L. JONES
Chief Engineer, Dry Ice Corp. of America
New York, N. Y.



Although unknown to the trade ten years ago solid carbon dioxide is now sold in larger tonnage than the liquid product. This development has resulted in an industry with a daily productive capacity in the United States of more than 700 tons

TEN YEARS AGO an outline of the uses of carbon dioxide, with special reference to commercial liquefied carbon dioxide in steel cylinders was prepared (*Chem. & Met.*, Vol. 29, 1923, and *Canadian Chemistry and Metallurgy,* 1923) at the expense of the Compressed Gas Manufacturers Association, in the hope of stimulating interest in new outlets for liquefied carbon dioxide. This seemed desirable because of a chronic condition of excess carbon dioxide production capacity—a condition not uncommon with other staple products in the United States. In 1923, some 58 different outlets for the product were listed, although 90 per cent of the liquefied carbon dioxide then sold was consumed in only one of these—the carbonation of beverages—and most of the remainder was used in charging compression refrigerating machinery of the carbon-dioxide type. Since that time a new industry has been created by the discovery and exploitation of a limited market for carbon dioxide in solid form—more familiarly known as Dry Ice—now sold in larger tonnage than the liquid product.

Actual and Proposed Uses

The purpose of this article is to present and discuss the actual uses and proposed uses of solid carbon dioxide. Since in many cases the solid, liquid, and gaseous forms are interchangeable in commercial work, applications of the three phases must be included.

There is in the United States a daily productive capacity of more than 700 tons of solid carbon dioxide, with the maximum daily demand not exceeding 350 tons during the summer season. As the mid-winter demand shrinks to one-fifth of this figure, it is apparent that production capacity is far in excess of demand at all times. In the best year experienced to date gross sales in the United States amounted to less than $3,000,000, of which about 90 per cent was derived from the ice cream industry. These statements are made as a preliminary to a discussion of the present and potential uses of solid carbon dioxide, in order to avoid any false impression of a large, unsatisfied demand for this product.

It should be further noted that the business is primarily one of merchandising and distribution. Like transportation, solid carbon dioxide must be available when needed; in many respects its sale may be compared with the sale of power. Neither product can be stored without a cost in excess of the mere carrying charges and market hazards of holding the product. The effects from duplication of distributing systems for both products are also comparable, as any paralleling of distribution facilities not only results in decreasing revenue and increasing unit expense for each system; but the losses in each of the distribution systems are greater, additional energy transmission losses in one case and greater evaporation loss in the other. Realization of selling prices at which certain prospective uses of solid carbon dioxide can absorb additional tonnages must await not only the elimination of waste and duplication in distribution but also the means of avoiding both the heavy costs of small-scale production as well as of long-distance transportation from large central plants.

The accompanying outline is intended to be inclusive rather than exclusive and suggestive of lines of new development as well as historical. In some cases, e.g. in connection with refrigerator cars (*Railway Age,* Feb. 14, 1931), many serious and difficult problems of the distribution of the perishable solid carbon dioxide must be solved, and far-reaching exchanges of obsolescent equipment effected; arrangements of transportation agencies must also be revised before railroad refrigeration can be regarded as an important outlet for solid CO_2. Such changes require many years for accomplishment and can at best produce only a small, albeit steadily growing demand in the near future.

Such uses have nevertheless been included in the outline, without differentiation as to the tonnage now used for the various purposes or the difficulties impeding the growth of the market in each subdivision, in the hope that those concerned may be prompted to investigate more closely the uses that affect or interest them. It is by no means certain that an attempt at this time to evaluate accurately the relative future importance of the various uses would be any better than a poor guess, as the entire field is comparatively new.

In the brief discussion following, principal attention is given to those uses for which commercial carbon dioxide is marketed; although for the sake of completeness, uses for which carbon dioxide is not bought and sold, such as carbonation for the decomposition of calcium saccharate in the beet-sugar industry, are included in the outline without comment. Despite efforts to extend the market, about 90 per cent of the liquefied (cylinder) carbon dioxide sold is still employed in carbonating beverages, while about the same percentage of the solid product is used by the ice cream industry. The remainder is sold for the various purposes indicated in the outline, some of which are believed to be capable of considerable expansion, while others will probably never absorb any large tonnage.

In regard to the outlets for food refrigeration, considered collectively, it may be said that solid carbon dioxide enjoys its best favor in competition with other forms of refrigeration when the temperatures required are below the freezing point of water. There is, however, a small but growing use in truck and package shipment of unfrozen meat, and a still smaller and less developed use in shipping fruit, vegetables, and flowers. With the latter products, however, the highly seasonal and uncertain volume involved, the market hazards, and the evaporation loss experienced in shipping solid carbon dioxide any distance to meet uncertain requirements conspire to render a rapid growth in demand very unlikely.

Food Refrigeration

In respect to food refrigeration, it will furthermore be seen that solid carbon dioxide is primarily a transport refrigerant. Its advantage cannot be attributed to any single factor, but results from its dryness, its relatively high specific gravity (1.45-1.50), its high refrigerating effect (about 278 B.t.u. per lb.), its low temperature, and the insulating and desiccating action of the gas evolved. There is also a possibility of utilizing it in light-weight transportation vehicles of smaller size, and of less costly construction, requiring less maintenance, because no water resulting from sweating has to be handled. Combination of these factors has made it possible in some instances to substitute 1 lb. of solid carbon dioxide for as much as 15 to 20 lb. of water ice,

though more often 3 to 6 lb. of water ice is displaced. When it is considered that the refrigerating effect of solid carbon dioxide, in B.t.u., is slightly less than twice that of water ice, it is at once apparent that latent heats alone, although an accurate measure of ability to cool or freeze other products, fall far short of expressing the relative ability of refrigerants to keep products at the desired temperature, or to maintain refrigeration.

As this is a year for new catch-words, it is felt that this combination of functions could well be summed up in a new word, such as "stafrigeration," "statifrigeration," or "coldservation," indicating collectively all of the factors involved in keeping a product cold, as distinguished from cooling it. It is in all events this property, and not the mere abstraction of energy from other materials, that makes solid carbon dioxide most useful in transport refrigeration—its principal market. The growth of this market is determined by the credit available to the user with which to effect changes in the older types of equipment, and increase in this logical market can only proceed at the rate at which such old equipment is replaced.

There are naturally many complicated problems in shipping specific perishables, and various ramifications of container size, temperature required, cost limitation, time and temperature of shipment make it necessary to treat each new condition as a special case requiring individual attention.

For cooling and freezing, solid carbon dioxide is used commercially only where required low temperature or other special conditions justify the relatively high cost per thermal unit. An interesting instance is the shrink-fitting of machine parts; by chilling parts such as cast-iron cylinder liners and valve sleeves this method has replaced press-fitting operations with less capital invested and at less operating cost (*Machinery,* Vol. 39, p. 305, 1933). Savings have been effected in assembling light-alloy airplanes with air-hardening aluminum alloy rivets which have been held in refrigerated boxes at the assembler's bench to prevent premature hardening.

Hardening Alloy Steels

In the radio tube and neon sign industries many operators have found in solid carbon dioxide a convenient and economical method of cooling vacuum traps, more readily available and practically as effective as the liquid air formerly employed. Greene and Luerssen (A. S. S. T., Sept., 1931) have reported on certain chrome-nickel and nickel-silicon steels which may be hardened by chilling with solid carbon dioxide after machining. Such treatment naturally minimizes any dimension change in the steel and prevents scale formation or changes in surface composition which play a part in heat treatment.

In Europe, machines have been designed employing solid carbon dioxide in small ice cream freezers intended for rapid freezing of cream as required by the dispenser on his counter or in store-front ice cream stands. At least one such machine has appeared in this country, but no small unit type freezer has proved well suited to the American ice cream distribution system.

In hardening fancy forms of ice cream, however, solid carbon dioxide has been employed with good success, as many ice cream manufacturers find that compact centralized operation of this department, with more rapid turnover of molds, facilitates speedy operation despite the rather high refrigeration cost per B.t.u.

The use of the solid material in histology (*J. Lab. Clinical Medicine,* Vol. 16, p. 627, 1931) and its application to sundry laboratory operations, such as cold testing oils, tests of properties of materials at subzero temperatures, cooling vacuum traps, low-temperature fractional distillation, and the preparation of rubber samples for pulverizing, are familiar to the chemist and need not be reviewed. The quantities consumed for such purposes are naturally small. In the laboratory, too, solid carbon dioxide at present prices makes freezing occasionally a better way of separating mixtures than other methods.

Trimming Golf Balls

An interesting and apparently well-established use is in the trimming of golf balls, where solid carbon dioxide merely serves to chill the rubber or gutta percha to a consistency favoring quick, neat trimming. Somewhat similar is the case where an airplane manufacturer found that crepe rubber for sound-proofing, which is almost impossible to trim accurately to size at room temperature, may be chilled to the desired consistency between blocks of solid carbon dioxide and trimmed as easily and as accurately as cardboard.

An interesting application is for stopping flow in pipe lines (*Chem. & Met.,* Vol. 37, p. 643, 1930) in an emergency where no valve has been provided. Rate of flow, temperature and composition of liquid, and size of pipe, are important factors, but fluids such as sulphuric acid in small to moderate-size lines are readily frozen by packing a short section of the line in solid carbon dioxide after which the necessary repairs or replacements may be made.

Almost any material which shows any tendency to ball or gum when ground or dry-mixed at room temperature is benefited by addition of solid carbon dioxide. Not only is the cooling applied in concentrated form directly to the dry material with minimum losses, but the evolved carbon dioxide aerates the powder and impedes further aggregation of the particles. The question of justifying the cost of such an addition depends upon the individual case, but at present a small use has been established in grinding dyestuffs and in dry-mixing certain flour mixes containing shortening. While most of these applications represent only a small outlet, they may suggest other uses in industry.

A small amount of solid carbon dioxide is now regularly consumed in modifying the atmosphere in cold storage rooms for eggs (*Ice Refrigeration,* p. 253, 1930). Much work has been done to determine the effects of an atmosphere of carbon dioxide on other materials, such as flowers, apples, grapes, and similar products (U. S. D. A. Tech. Bul. No. 318), and there is reason to believe that in the successful cold storage of the future not only the temperature, humidity, and rate of ventilation will be controlled, but the percentage of carbon dioxide and perhaps also of oxygen may be adjusted to the optimum condition for each type of product.

Carbonated milk (Van Slyke & Bosworth, N. Y. Agri. Exp. Sta. Bul. No. 292) was once considered to have distinct merit and is certainly as palatable and as worthy of public favor as many beverages now on the market. An atmosphere of carbon dioxide is used in the canning

of dry products susceptible to oxidation, such as powdered milk, shredded coconut, and cocoa preparations. Recently the carbonation of moist canned products has been advocated on the basis that the reduction of pH permits rapid cooking at lower temperatures. The principal outlet for liquid carbon dioxide in the food industries, however, is in the carbonation of beverages and of carbonated water—so familiar and so well described elsewhere as to require no comment here.

The pressure generated by liquefied carbon dioxide forms a convenient decentralized source of mechanical energy, serving such purposes as to operate bell and whistle buoys, to force obstructions from plumbing, to operate railway signals at remote points, to operate small paint sprays for guns in sign painting, and to make field tests of small tanks and sheathed cables for leakage.

An Explosive in Mining Coal

A recent application is in cleaning water wells, where in many instances it has been found possible to increase flow by dropping blocks of solid carbon dioxide into the casing under conditions favoring the generation of gas pressure in the water bearing structure.

Liquefied carbon dioxide has also come into favor as an explosive in mining coal, under the name of the Cardox system. It is employed in heavy steel capsules provided with an internal device which when electrically heated, raises the pressure in the capsule sufficiently to burst a frangible disk and suddenly release the carbon dioxide. The resulting action is slower than for other explosives and is said to produce more lump coal and less fines on that account. (Kneeland, *Chem. & Met.*, Vol. 39, p. 433, 1932.)

Large amounts are required for the original charge and for replacement in compression refrigerating machinery (J. H. Pratt, *Ind. & Eng. Chem.*, Vol. 24, p. 613, 1932), now widely used in air conditioning of theaters and in marine refrigeration.

The principal uses of carbon dioxide in chemical industry employ the impure product generated in process, usually in the form of stack gases. Hence they do not appear in the carbon-dioxide trade, and will be passed with little comment. In the manufacture of white lead, by the wet process, synthetic urea, carbonates, and for carbonation in the beet sugar industry, its use is familiar to chemical engineers and well described in existing literature. A newer use is in the preparation of sodium perborate, for which purpose the consumption is appreciable. Abroad, pure solid carbon dioxide is sold commercially, in some volume, for the manufacture of salicylic acid, but in the United States the tendency has been to use rich kiln gases generated at the plant. As a vehicle in distilling oxidizable materials, and for the protection of such materials as cod liver oil from oxidation, its virtues are obvious.

Less obvious is the fact that when shipped in solid form it possesses many advantages for use in neutralizing alkalis. Thus, it is non-corrosive, easily handled, and in neutralizing replaces more than twice its shipping weight in sulphuric acid, or about five times its weight of hydrochloric acid. At least one chemical company now purchases solid carbon dioxide for use in neutralizing at a price per pound of hydrogen ions less than the cost of sulphuric acid.

Since carbon dioxide is the starting point for photosynthesis, its presence in greenhouse atmospheres is an important factor in determining the rate of plant growth and reproduction. Although much work has been done on the subject, no commercial sale of liquid or solid carbon dioxide for this purpose is now known in this country.

As a respiratory stimulant, particularly in hospitals and mine rescue work, a small but steady volume of carbon dioxide finds use, and indeed the carbon dioxide-oxygen "inhalator" of Henderson has almost universally replaced older types of apparatus for resuscitation. The physician has long been familiar with it in solid form for the removal of skin blemishes.

As an insecticide, solid carbon dioxide either alone or in combination with ethylene oxide (Duval, *Food Industries*, Vol. 2, 1930) has proved effective in fumigating grain, while the liquid form combined with ethylene oxide is applicable to a variety of fumigation problems.

The use of liquid carbon dioxide in the fire protection field has grown in ten years to a position of wide use and recognition (*Nat. Fire Protection Assoc. Quarterly*, Oct. 1924, and Jan. 1930). Its fire record has been excellent, and while the consumption of carbon dioxide is naturally small because of the non-repeat character of the business, the carbon dioxide type of fire extinguishing equipment continues to preempt an increasingly important position in this field. Consumption of carbon dioxide, however, is but a fraction of 1 per cent of the industry's output, representing in value less than 5 per cent of the value of the fire extinguishing devices which employ it. As solid carbon dioxide increases in availability, the possibility of direct application to special problems, such as cellar, manhole, ship's hold, and coal pile fires becomes of interest.

Among the miscellaneous uses may be mentioned the recarbonation of city water supplies, now a well-established adjunct of lime-soda water softening in more than a score of American cities (*Eng. News-Record*, Vol. 90, 1930). Virtually all of this gas is produced in the softening plants by combustion processes, but the use of purchased solid carbon dioxide has an appeal in convenience, purity, and ease of application which is receiving some attention.

As a "Rain Maker"

Considerable work has been done on applications of carbon dioxide in the rubber industry, more particularly to its use with steam in inflating air bags under close temperature control. In Holland some trials of solid carbon dioxide distributed from airplanes over clouds as a "rain-maker" have been made, and reported as producing the desired result. The importance of atmospheric carbon dioxide in the hardening of portland cement is well-known, and at least one manufacturer takes advantage of it by curing portland cement composition articles in a carbon dioxide atmosphere.

The removal of carbonate and carbonate-bonded scales from piping systems is a secondary effect observed in cities where the water supply is regularly recarbonated. A similar mechanism of scale removal has been employed in a few instances for removal of scale from clogged industrial pipe lines by temporarily carbonating the water (*Power*, Vol. 55, p. 422).

Pulp and Paper Industry Assumes Leadership in Use of Alloys

EDITORIAL STAFF REPORT

THE TECHNICAL Association of the Pulp and Paper Industry held its annual meeting at New York City, February 13 to 16, 1933. The size of the program necessitated four instead of the customary three days. The social feature of the session was the special luncheon. Dr. Walter Rautenstrauch of Columbia University, a former associate of Howard Scott, the well-known technocrat, addressed the assembled members and their guests on the future prospects of business and of the pulp and paper industry.

The convention lived up to its reputation for unusual interest in alloys. The materials of construction symposium can always be counted on for lively discussion of the subjects covered by the speakers. At this particular meeting interest centered upon the specification proposed by the committee for chromium-nickel alloy castings for use for sulphite pulp processing, such as relief valves, strainers, pumps, and digester fittings.

The chemical composition of the proposed alloy steel included:

Element	Content Per Cent
Chromium	20 min.
Nickel	9
Carbon	Less than 1/100 of chromium content
Sulphur	0.05 max.
Phosphorus	0.05 max.
Silicon	Left to producer
Manganese	Left to producer
Iron	Balance

Molybdenum may be specified from 2 to 4 per cent at the option of the purchaser. The heat treatment, physical and mechanical tests, pickling, workmanship, finish, and other properties are treated in the specification.

A report upon an investigation of five castings of chromium-nickel-iron alloys that had failed and one that had not failed in sulphite service, was made by F. L. LaQue and G. L. Cox of the International Nickel Co. Every casting that failed was of low alloy content, being generally deficient in chromium in relation to carbon. The corrosion which occurred followed the path of an intergranular material, presumably carbide.

It would seem then, according to the authors, that the intergranular constituent is definitely associated with intergranular corrosion and that it can be taken into or kept in solution by proper heat treatment, with consequent benefit to the resistance of the alloy to intergranular attack as measured by the accelerated test in the laboratory. It is reasonable to expect that such benefits of heat treatment would extend to resistance to attack by sulphite liquor in service.

It is also evident that proper heat treatment of alloys of this type provides at least one means of insuring satisfactory performance in sulphite liquor. This has been demonstrated by the general success of heat-treated castings now in use.

Any method of lining plain carbon steel with stainless steel must depend upon welding for its success, according to W. E. Jominy and R. S. Archer, of the A. O. Smith Co., in their contribution on stainless steel linings for vessels used in chemical processes. Recent developments have made possible the welding of these steels to plain carbon steel by rolling. The product composed of a thickness of one-quarter stainless steel and three-quarters carbon steel may be obtained for a cost of roughly 50 per cent of that of solid stainless steel of the same composition. The three small lined digesters built for large scale laboratory operation have been in operation for more than a year, and no difficulty has so far been reported from their use.

While some difficulties have been encountered with stainless linings, they should be very small compared with the difficulties with the present ceramic lining. The latter, as is well known, requires constant vigilance and continuous repairing to keep it in shape, and entails occasional shut-downs.

Economically, the metallic lining should have advantages. The annual charges for the ceramic lining average about $1,500 per digester. This figure is based upon an average cost of lining of $6,000 per digester of 12.5 tons capacity, having an average life of 7 years, and includes a maintenance cost of $460 per year.

Investigations made by these authors have indicated that the annual charge on a metallic lining would be appreciably less than $1,500. In addition, a digester of the same outside dimensions would have increased capacity, due to increased inside diameter and elimination of shut-downs for lining repair. The increase in inside diameter alone, due to the substitution of metallic for ceramic lining, would result in about 14 per cent increase in capacity.

This research in the development of a satisfactory metallic lining for pulp digesters is still in progress. It has reached a stage where trial of larger units is logical, and the future development will require close cooperation with the paper industry. Metallic linings are working out satisfactorily in the oil industry and are making headway in the chemical industry. With further development they should be advantageous to the paper industry.

The production of stainless steel-lined digesters was

discussed also by Wallace C. Johnson of the Plykrome Corp. He has accomplished this type of construction by welding together, in the absence of air, under heat and high pressure a combination of an extremely thin chrome-nickel sheet not more than 0.050 in. thick and a mild steel plate by inserting between the two a bond of fusion sheet of commercially pure iron. This composite stainless steel can be readily bent and formed similar to ordinary steel. It is, said Johnson, particularly well adapted to the use of electric arc welding for fabricating it into an acidproof lining.

The F.M.P. method of sulphite pulping was described by Andreas Christensen, sulphite superintendent, Rhinelander Paper Co. The installation of one of the first forced circulation and indirect heating sulphite systems in the U. S. was covered in detail together with a review of benefits derived from the system. This system of sulphite cooking has been generally adopted in Europe where a survey in 1931 showed 125 installations.

In reviewing this development from the standpoint of the entire mill, and not merely as an improved method of cooking, Christensen has drawn the following conclusions:

Digester and acid plant

1. Increased yield from same quantity of wood.
2. Additional capacity with same cooking hours by introducing more chips.
3. Material saving in steam used for cooking.
4. Saving in sulphur and lime.
5. Improved operation of acid plant and recovery system by eliminating wet relief.
6. Considerable less cooking capacity required for relief.
7. Possibility of using automatic control if desired.

Bleach plant and screen room

1. Lower bleach consumption if desired, with improved color and strength.
2. Less variables in bleachability.
3. Reduction in screening.
4. Improved operation of screening system.

Boiler room and power plant

1. Less raw water treatment required by the return of condensate.
2. Saving of more than one-third of the coal as compared with the direct cook.
3. Improving boiler efficiency by eliminating excessive peak loads.
4. Reduction in power cost by the use of either bleeder or exhaust steam of low pressure.

Wood yard

1. Reduction in inventories by cooking greener wood. This factor will tend to reduce the loss due to decay to a minimum.
2. Money tied up in inventories may be released for other work.
3. Saving in taxes and insurance.

The manufacture of a high-grade rag paper from colored rags has long been a problem in the rag paper industry. The supply of white rags is not sufficient to meet the requirements of the rag paper mills and colored rags are widely used. The various cooking processes used in the past to effect the removal of dyestuffs from colored rags has consisted of treatment which removed the color at the expense of the strength and quality of the fiber. Cooking processes which have performed a satisfactory color removal have yielded a weak half stock, and cooking processes which yielded strong stock did not effect satisfactory color removal.

An experimental study of the cooking of new blue over-all clippings to obtain a rag stock of good color and high strength was described by Samuel Lenher, organic chemicals department, E. I. du Pont de Nemours and Co. A cooking process was described which gives a stock suitable for use in 100 per cent white bond paper. This process consists of a short mild alkali cook followed by a wash and successive short cooks with alkaline hydrosulphite; all stages in this process are carried out in the usual rag boilers. Mill trials show the process operates satisfactorily in production.

During the four sessions many other interesting papers were presented, such as, cellulose from the whole cotton plant, by H. R. Murdock; white pulp from slash pine, by C. H. Herty; and the degradation of rag stocks on cooking with alkaline solutions, by Laughlin and Lewis; but space does not permit including them here.

Asphalt-Impregnated Tile

EXPERIMENTS conducted over a period of years at Los Angeles Harbor demonstrated to the satisfaction of many, including the harbor authorities, that concrete piers could be insulated against the destructive effects of the sulphates in sea water by impregnation of the piers with asphalt under the vacuum-pressure process, similar in many respects to the process employed in creosoting piles. Engineers in charge stated that properly impregnated concrete piling should last 75 years or more.

The vacuum-pressure process has now been extended to the asphalt-impregnation of tile, securing impregnation of the tile to a depth of 2 in., or complete impregnation when the tile was less than 2 in. deep at a cost which permits its general installation. In order to facilitate placement the impregnated tile is now produced in sections for lining sewers and disposal tanks, metal pickling tanks, drainage pipes, and irrigation ditches.

The asphalt-impregnated tile has been immersed in 50 per cent and 75 per cent by volume sulphuric acid for months and the laboratories report no change in the tile; tests indicate that the insulation of the tile through its impregnation with asphalt is as effective as is the insulation of asphalt-impregnated concrete.

For the production of the tile a clay is selected with a minimum amount of non-colloidal material and free from mineral sulphates and other solubles, which bakes with a certain degree of porosity, that is, not too dense to prevent thorough impregnation of the asphalt. The clay is then baked in the ordinary way. The tile is placed in a retort in which the air is exhausted, the temperature slowly raised to 250 deg. F., and hot asphalt is forced in under pressure. It is allowed to cool in gradual drops of the temperature of the retort.

Through the use of the new asphalt-impregnated tile or concrete liners an effective and economical method of insulation for pickling vats is provided. Vats of cement concrete thus lined will be insulated against the action of sulphuric acid.

C. G. M. A.
Looks to New Uses for COMPRESSED GASES

EDITORIAL STAFF REPORT

■

Left: F. J. King, chief engineer of the Linde Air Products Co., was elected president. Right: Franklin R. Fetherston was re-elected secretary and treasurer of the Compressed Gas Manufacturers' Association

WHEN the Compressed Gas Manufacturers' Association was founded March 21, 1913, its constitution stated that one of its objects was "to extend the gas industry by ascertaining new fields in which gases might be used." In the twenty years since that time the industry has grown from an output of about \$10,000,000 in 1914 to well over \$50,000,000 in 1929. Much of this growth has been due to new uses, but the twentieth annual meeting held in New York, Jan. 23 and 24 was the first in recent years to confine its technical program to a study of such applications.

An introductory paper, "What's Ahead for the Compressed Gas Industry?" by S. D. Kirkpatrick, editor of *Chem. & Met.,* sketched some of the new fields of possible exploitation in air conditioning, sulphur dioxide removal, and in the artificial forcing of plant growth by atmospheric control.

Oxygen and acetylene were shown by Glenn O. Carter of Linde Air Products Co. to underly important processes in most of the basic industries of the country. The dependence of the metal-working fields, the railroads and shipyards for these cutting and welding gases is better known than even more important contributions in the construction of gasoline and crude oil pipe lines, in aircraft production and in chemical industries for plant piping, welded shipping containers and pressure vessels.

The medical gases, which include nitrous oxide, ethylene, oxygen, carbon dioxide, acetylene, and propylene, have come into increasing importance as chemical manufacturers have developed purer and more uniform products and as the medical profession has advanced its studies of gas therapy. Dr. Alvan D. Barach of the Presbyterian Hospital, New York City, reported on the clinical results of several years work with oxygen in the treatment of pneumonia and similar diseases. W. P. Uhler of the S. S. White Dental Manufacturing Co. reviewed applications of the medical gases in anaesthesia.

Members of the National Bottled Gas Association joined in one of the technical sessions when D. B. Williams of the Carbide & Carbon Chemicals Corporation and Richard D. Hudson of the New Jersey Industrial Gas Co. discussed the dependence of industry on the fuel gases. While manufactured gas sales last year dropped 12.6 per cent below 1931 and natural gas was off 15 per cent and fuel oil 9 per cent, butane sales actually increased by 14 per cent.

A. H. Hooker, technical director of the Hooker Electrochemical Co., pointed out in his paper that the market for chlorine in sewage disposal (now less than 2 per cent of the total) could be expanded many times if communities could be convinced of its value. The bleaching of kraft paper was cited as another outlet that might well be increased without cutting into the largest existing market which is in the paper mills.

F. A. Eustis, secretary-treasurer of the Virginia Smelting Co., stated that new large-scale uses for liquefied sulphur dioxide might well result in lower prices for this chemical specialty since the productive capacity is now about twice the average consumption. The largest use is in refrigeration, although the recent trend is toward the use of smaller amounts in each mechanical refrigerating unit. The high purity of the liquefied gas makes it of increasing interest in chemical industry for use both as a solvent and as a reacting reagent.

A paper by J. H. Pratt of the Liquid Carbonic Corp. showed that approximately 40 plants are now producing about 75,000,000 lb. of carbon dioxide per year in this country. Most of it is made by the coke process, but there is considerable byproduct production from alcohol and some gas is still obtained from natural wells. Beverages account for perhaps 90 per cent of the total output of liquid CO_2. Much of the refrigerating business has been taken by the solid material. Chemical industry offers a number of new outlets, none of which has yet assumed a large volume.

F. P. Gross, Jr., of the Air Reduction Co. outlined the commercial applications of the rare gases—argon, neon, krypton, and xenon—all of which are now available commercially through the fractional distillation of liquid air. Practically all of these gases find their principal market in filling electrical luminescent tubes. It is possible that argon will come into larger use as an inert atmosphere in certain chemical operations. Neon is used in the new sodium vapor lamp that has attracted some attention in the United States, but is being used commercially in Holland and elsewhere in Europe.

John Thomas Donahoe, an electrical engineering authority in the gas industry, discussed the trend of power costs, which, of course, constitutes a major element in gas compression. He stated that a gradual reduction in the capital investment per kw. of capacity is in definite prospect, that fuels will be lower in the future, and in fact every factor except taxes and interest would seem to indicate a trend toward eventual reduction in power costs.

What Becomes of the COLLEGE GRADUATE?

By ANTHONY ANABLE
The Dorr Co., Inc.
New York, N. Y.

ANTHONY ANABLE
Member Advisory Committee Course XV, Massachusetts Institute of Technology

ERWIN H. SCHELL
Head of department of Business and Engineering Administration, Massachusetts Institute of Technology

CAN A COLLEGE EDUCATION, aside from its cultural and social benefits, be justified on a monetary basis? If so, are financially successful graduates above or below average in scholarship; which courses are best designed to give early indication of later success? Is participation in fraternity life and extra curriculum activities a waste of time or a valuable part of undergraduate life? And finally, is the trend of graduates into executive positions great, and what industries and what classifications of jobs within these industries offer greatest opportunity for self-improvement and financial reward?

These questions have been discussed for generations by parents seeking to guide their sons to distinguished careers in business and industry; students, too, have argued pro and con. Not until recently, however, have illuminating, factual data on the subject been available. About 15 years ago, in June, 1917, Prof. Davis R. Dewey, head of the new department of Business and Engineering Administration at Massachusetts Institute of Technology, at the graduation of his first class, conceived the idea of following the careers not only of his initial group of 38, but of the first 1,000 graduates of his course, enlisting each of them in a fact-finding survey, to be completed in 15 years.

This course, the first 1,000 graduates of which were subsequently to become the testing medium for a new educational viewpoint, was established in 1913 at the request of a committee of alumni who recognized clearly that many engineering graduates did not, after graduation, follow their profession, but were drafted into commercial or managerial positions. They recommended a new course, the aim of which was to furnish a broad foundation for ultimate administrative positions by combining with a general engineering training instruction in business methods, business economics, and business law.

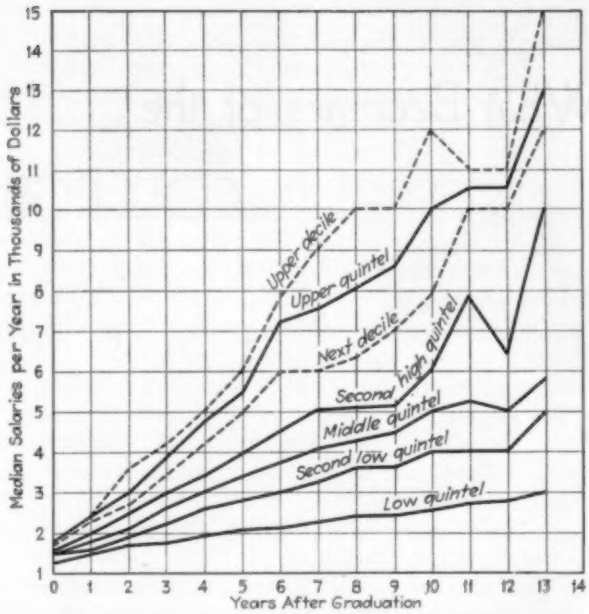
In 1930 the thousandth student graduated and the test group was complete. After a lapse of a year to allow the last class to be absorbed by industry the records of all were produced and correlated by Dewey's successor, Prof. Erwin H. Schell. Before considering the group as a whole, an inquiry into the men themselves should be made.

Among the 809 who supplied full data on their careers, virtually every state of the Union was represented, although New Englanders predominated. Each of 42 preparatory schools and 53 colleges had prepared at least four of them for their final course of study; the men were drawn from cities and towns in all population ranges, with neither large, small, nor medium-sized communities predominating. About two-thirds of them were sons of college men, and only in a few instances were father and son graduates of the same institution. Furthermore, parental influence was not pronounced, for the fathers of these men were engaged in a great variety of pursuits, some being proprietors, managers, and professional men, while others were engaged in commercial service, the building trades, manufacturing and mechanical industries, engineering and the machine trades.

In considering the salaries given in the following it should be borne in mind that these were earned during the halcyon days of the booming '20's, and consequently are from 15 to 30 per cent in excess of present salaries. Still, no error is introduced by these inflated figures, as the investigators were concerned not so much with actual salaries as with the comparative earnings of different groups of graduates and the reasons for the difference in remuneration offered these men by industry.

A startling difference in achievement, based upon earning capacity, was at once noted. In one-fifth of the group, called the upper achievement rating for purposes of comparison, the earned salaries increased year after year at the rate of $1,000; the middle fifth, or middle achievement rating, showed an average annual raise in pay of little less than $500, while the rate of increase in the lowest fifth, or lowest achievement rating, was

strikingly low; only after 14 years was a salary of $3,000 reached. When, as a group, the lowest achievement rating had attained this median salary of $3,000, the middle achievement rating had reached $5,700, and the upper achievement rating $13,000. Regarded from a slightly different angle, the salary secured by this lowest fifth after 14 years was secured by the middle fifth in five years and by the uppermost fifth in three years.



Salary for each quintel each year after graduation

Justification for Study

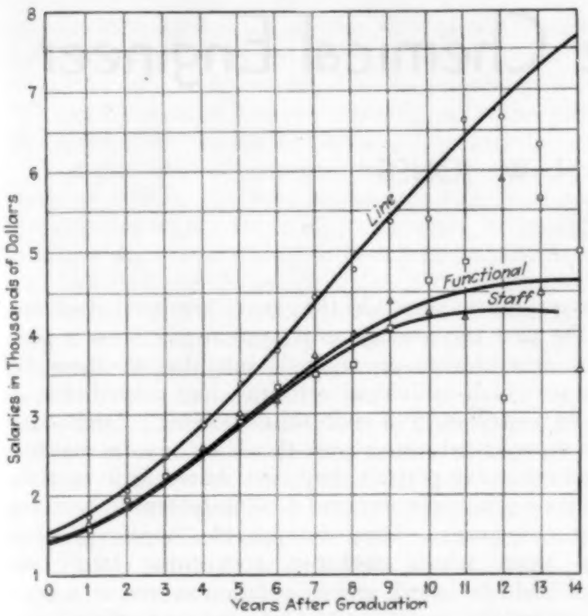
All of these men had had the same educational advantages and all had secured diplomas upon graduation. As a group they entered business and industry in minor capacities, such as apprentices, laborers, clerks, and salesmen, attaining greater responsibilities of minor and major executive positions as years passed. The justification for the course of study they had pursued is found in an accompanying chart which shows that of men 14 years out of college, 70.3 per cent had become major executives and 14.8 per cent minor. Yet why, the professor inquired, the wide divergence in the earning power of the five achievement ratings? Was the explanation to be found in geographical, social, or in scholastic conditions, or was the type of industry selected and the general class of position held therein of importance? These and many other factors had a bearing on the answer to the question, as a further critical study of the records show.

The survey showed that the most successful men came from the middle western states, and that those who did best in business life had completed college courses elsewhere before coming to the New England institute for their final work. First among the states producing successful graduates was Wisconsin, followed closely by Indiana, Ohio, Pennsylvania, Maryland, California, Michigan, and New York. At the bottom came Connecticut, preceded in ascending order by Rhode Island, District of Columbia, New Hampshire, and Massachusetts. Furthermore, those transferred from another college, either due to greater maturity or a predisposition to undertake the type of work for which the course was designed, did far better than the ones possessing only a secondary school education. Half of these college transfers reached the upper two achievement ratings, compared with only a little over a third of the secondary school men.

But New England's educational methods and the benefits of better than average scholarship were convincingly sustained when it was found that the men in the two upper achievement ratings did considerably better scholastically than their less successful classmates. The upper achievement rating showed definitely a higher proportion of men with honor, credit, and passing grades than the lower four groups, and a corresponding smaller proportion of men who at one time or another had secured low or failing grades. While this scholastic superiority of the most successful graduates was clear in all classes of study, it was strikingly apparent in business and economic subjects and in original thesis work. This again was logical and to be expected, as these particular subjects demand an unusual degree of initiative, imagination, and resourcefulness, the qualities that are always so immensely important in executive work.

Responsibility trend of Course XV graduates in per cent

Membership in social or Greek letter fraternities proved to a surprising extent a criterion of later business success, which conclusion should have a salutary effect upon those who libel the fraternity system as a hotbed of social snobbery and a gross waster of time. The upper achievement rating contained one-third more fraternity men than the group as a whole, the middle achievement rating was just up to average, and the proportion in the low achievement group was one-sixth less than the average. A similar



Salaries in many line, staff, and functional positions

trend, although not quite as emphatic, was observed for members of senior honorary societies. A clean-cut explanation of this correlation between fraternity membership and achievement is reached with difficulty. The reason may be that executive responsibilities require social qualities of a relatively high order, which fraternity life has a tendency to develop. On the other hand, the highly selective processes involved in fraternity membership may give heed to personal qualities, effective and valuable in executive positions.

Ultimate success apparently came to those who had led extremely active lives during undergraduate years and who had been engaged in a greater proportion of extra-curriculum pursuits than their classmates. Graded on a point system, determining the importance of the various activities and the time devoted to them, the members of the upper achievement rating were almost one-third more proficient in undergraduate activities than the average; the next two ratings attained average proficiency, and the two lowest ratings were distinctly below average.

Almost as important as undergraduate records was the industry entered and the nature of the work performed. From the standpoint of earnings the greatest opportunities were found in chemical and related processing industries, and in the manufacture of machinery, apparatus of various sort, and of instruments. Next in order came the construction, public utility, and metal-fabricating industries; the low salaried occupations were found in the insurance field and in educational and governmental services. A further subdivision of occupation, not according to industry but according to field of work, showed clearly that the most attractive fields were those of distribution, finance, industrial management, and professional services. Significantly, 63.5 per cent of the upper achievement rating were placed in one or the other of these four lucrative fields, while the same was true of only 48 per cent of the members of the low achievement rating. Breaking down the occupational analysis one step further according to line (executive), functional, and staff positions, the superior opportunities of the line positions were clearly brought out. Not only did the line men receive greater annual salary increments, about $500, than the others, but there seemed to be no limit to the salary ultimately attained, whereas the opportunities in functional and staff positions appeared to be limited to about $5,000 per year.

Strange as it may seem, an easily perceptible predilection to succeed seemed to be stamped indelibly upon the ultimately successful members of the group as early as in their twenty-second year. How could the fact otherwise be explained, that the members of the upper achievement rating, upon graduation, received more and better offers than their less successful classmates in the low achievement rating? Members of the upper achievement rating received proportionately more offers of from two to nine jobs, and a proportionately greater number of the members of this group received initial salaries ranging from $2,000 up to $5,000.

Instead of drawing any definite conclusions and hazarding any conjectures how to apply the lessons learned to educational work, it may be better to sum up the characteristics of the median man in the upper achievement group, so that he may stand forth in bold relief as an example of what modern industry probably desires in its future administrators. The governing characteristics of honesty, character, and other personal qualities not covered by these studies are to be taken for granted, but in addition our hypothetical man should probably have the following background, if these studies are to be relied upon.

1. A good standing in class-room work, well above the average in all subjects, but especially high in thesis work, and in business and economic subjects where latent initiative, imagination, and resourcefulness are developed.

2. Proficiency in extra-curriculum activities, particularly those calling for managerial and organizing abilities and the subtle technique of leading others and making the others like to be led.

3. Ability to get along well with others—a natural and deserved popularity if you will—indicated by election to membership in honorary and social fraternities.

4. Success in securing employment in a growing and remunerative industry, such as the chemical and related processing industries, a gradual working into the more lucrative fields of that industry, such as distribution, finance, and management, and finally the attainment of an executive position in the active direction of that industry rather than a less remunerative functional or staff position.

Number of Positions and Starting Salaries Offered at Graduation

Number of Positions Offered at Graduation	Per Cent Achievement Rating		Highest Salary Offered	Per Cent Achievement Rating	
	Upper	Lower	Dollars	Upper	Lower
9	0.9	0	$4,500–$5,000	3.0	0
8	0.9	0	4,000–4,400	0	0
7	0.9	0	3,500–3,900	2.0	0
6	0.9	2.2	3,000–3,400	5.0	2.4
5	8.3	1.1	2,500–2,900	8.0	2.4
4	12.3	7.7	2,000–2,400	24.4	4.7
3	32.7	30.8	1,500–1,900	43.6	50.7
2	23.1	23.1	1,000–1,400	13.8	40.1
1	20.2	35.2	....	....	....

Appreciation is expressed to Professor Schell, present head of the Department of Business and Engineering Administration, for access to the data upon which this paper is based, and for permission to present these findings in this form.

Cost Accounting and the Chemical Engineer

By A. G. PETERKIN AND H. W. JONES

Atlantic Refining Co.
Philadelphia, Pa.

DURING the past twenty years a continual conflict between accountants and technical men has smoldered beneath the surface of industry, characterized in its earlier stages by considerable intensity of feeling, but more recently simmering down to a friendly recognition of different points of view and a joining of forces to attain mutual objectives. That this strife should have occurred is not surprising. The accountant, steeped in the tradition of an age old profession, and accustomed to regard himself as the confidential steward of his employers and his ledgers as sacred records to be exhibited only to the members of the firm, could hardly be expected to welcome the prying inquisition of the technical upstart to whose scientific spirit nothing was sacred. The one was essentially a tory and ultra-conservative; the other most certainly a progressive, and to the minds of many, a radical. In this case industrial history has vindicated the latter.

Within the last century industrial processes have gone through a stage of rapid evolution, and progress has always been in the direction of increasing size and complexity. As a result, design and operation of equipment have proceeded from the hands of the owner into those of the manufacturing staff with its numerous highly specialized sub-divisions. Intimate knowledge of design and operating detail has moved in the same direction. The executive of a hundred years ago based his decisions and shaped his policies largely upon his own knowledge and experience, and from our point of view leaned but lightly on his subordinates. The decisions and policies of today's executive are based on information provided almost entirely by the members of his staff, for the soundness of which he relies far more upon the character and reputation of the contributing individuals than upon his own familiarity with the various specialized aspects of each question. It would appear that had the accounting methods kept pace and in step with this manner of growth, information would have been disseminated more and more widely as time went on, so that each contribution to a decision or policy would be based upon a sound knowledge of its own and general company economics. Only in recent years, however, has the conservatism of the accountant yielded to changed conditions.

The general accounting system of a company periodically lays before the management balance sheets and operating statements showing current assets and liabilities, gross income, cost of selling, cost of manufacture, and net profit for the period. The cost system has contributed nothing to these figures except the evaluation of inventories of partly finished and finished goods, which is necessary to determine profit or loss. Total expenses distributed by the cost accounting procedure must equal total expenditures shown by the general accounting system.

In the past the average cost system has been a post-mortem instrument—an analysis intended to show the extent to which individual activities had contributed or failed to contribute to a successful showing. Such statements represented water-over-the-dam; insofar as they covered extensive periods they contributed little or nothing to day-to-day economy and good judgment in handling current exigencies. They did provide, however, information upon which decisions concerning long time policies could be based, and in addition served as a point of departure for investigations into the *past* efficiency of the various phases of management.

Cost Systems in Management

To the sales manager were presented the cost of making sales, the manufacturing cost of goods, and the income from their sale. Apart from the question of selling expense, it appeared a simple matter to supply all the information needed to determine the success of his past and the direction of his future efforts. Obviously what he wanted from a manufacturing cost system was a unit cost of each product. Unfortunately individual unit costs in many cases do not exist in fact, and so cannot be calculated. This is the case where the members of a group of finished materials are dependent for their production one upon the other. It does not matter that one or more may be called byproducts, or that one may incur more expense than another. The only calculable thing, by the very nature of the operation, is the total cost of making the group. Moreover, the sales department must dispose of the entire group in the relative quantities made. Consequently, in the last analysis, the sales manager must compare what he can get for the group as a whole with what it cost to produce and market it. In addition, he wants to know how costs vary with volume of production. A system which presents costs subdivided into items independent of, and those varying with, volume of production will help intelligent consideration in this direction, but as the variations are neither regular nor in the same ratio throughout the production range any major variation must be studied independently.

We come now to the manufacturing manager—in chemical plants, generally, a chemical engineer. Cost statements, to be useful to him must reflect *currently* the economy of his operations so that inefficiencies may be detected and remedied as soon as they occur. In addition to actual plant operation the manufacturing manager will participate in all questions of policy with the sales and financial managements, and with the general management. Questions as the addition of new products, increasing or decreasing the volume of business in this or that direction, improvement or expansion

The first of two articles, modified slightly from the paper presented by the authors under the same title before the American Institute of Chemical Engineers at Washington, Dec. 8, 1932.

of present processes or facilities, are all referred to him for study and comment. Here he assumes the rôle of economist and it is evident that the ease with which all this can be done will depend greatly upon the skill with which the statistics are gathered and arranged.

It is this field of activity, that of the manufacturing manager, which the cost accountant has been tardy to recognize as legitimate in all its phases. It has appeared to him a dangerous thing to broadcast, relatively speaking, values hitherto known only to the higher officials, and he has naturally felt that the cultivation of any such policy would automatically tend to undermine his time-honored rôle of financial analyst and confidential investigator. When manufacturing units were on a small scale the locations of office and factory were often identical, and it was possible for the accountant to keep physically in close touch with plant operation and plant management; the combination of individual units geographically wide-spread to form large corporations under centralized control has often destroyed both personal and physical contact, at once increasing the accountant's, and decreasing the plant manager's reliance on statistical information—an unfortunate thing for both. The very neglect of this field by his more conservative associates made it an especially attractive market for the consulting accountant, who, forgetting tradition, saw the situation as it really existed, and devised systems which would meet the requirements of *plant* management and at the same time furnish reports for the *general* management. As a result, we now have in our hands glittering new tools such as "standard costs," and "budgetary control."

Fundamental Aims of Costing

Having had a mushroom growth, all these systems are fundamentally as alike as one mushroom to another—slightly different in size, shape and color, perhaps, but basically of the same stuff. The aim of all is to provide for each operation, for each group of operations and for the entire plant, a series of measuring sticks by which actual performance may be scientifically evaluated. In place of the multitude of comparisons presented by past history with all its attendant modifying circumstances, they apply definite, previously agreed-upon standards—not definite in the sense of being invariable, but on the contrary constantly variable in order to give a true, up to the minute basis for comparison. To take one of the simplest cases: if production figures are to be compared at the end of each calendar month, the volume in February will be less than in January, and the system automatically shortens the measuring stick in the ratio 28:31. Again: the change in price of raw materials is out of the control of the factory management; what control is applicable is in the hands of the purchasing department. The system recognizes this, and automatically separates the fluctuation in total cost due to increase or decrease in the price of raw material. Thus the official studying the statement loses no time in questioning the manufacturing manager regarding increased costs due to price changes—the system immediately and automatically turns his head in the right direction—to the purchasing department. Still a third example: to the extent that cost may be shown to be above or below standard due to change in production rate the responsibility may lie either with the manufacturing or the sales department, or with business conditions entirely beyond the control of either, as inquiry will bring out. Thus these systems purport first to separate the constant and variable items of cost, then automatically to show to what extent the total variation of each cost from standard was influenced by each of the various factors affecting cost, and finally to lay automatically each variation at the feet either of the responsible individual or of Providence, as the case may be.

What Do Costs Cost?

But cost departments are expensive—what about the increased cost of the costs themselves? Here again these new systems have followed the trend of modern industrialism. By focusing expert, intelligent, and intensive study on the problem beforehand and by applying a few simple principles, an automatic system of analysis is devised whereby the computation of periodic analytical statements becomes a mechanical routine easily performed by relatively inexpensive labor. The thinking is done beforehand; the clerical force adds, multiplies, and divides, and enters the results in the right column.

Establishment of proper standards is obviously an important factor in the practical application of such a system, and may proceed from one of several points of view. Each standard may epitomize past history; it may be an ideal unattainable in practice, as the carrots hung before the donkey's nose; or it may be a reasonable expectation for a given period, arrived at by consideration of past history, current values of raw material and labor, and present and potential sales demand. The advantages of the first two points of view must be left to their proponents; what follows deals with the last, as it involves a general method of management to which the particular cost system used is merely an incidental aid.

This method consists in:

1. A detailed forecast of production, based upon a similar forecast of sales over a period the length of which depends upon the degree of control required to cope with the business fluctuations generally encountered in the particular industry.
2. An estimated direct cost of each individual operation involved in the production of the forecasted quantities.
3. An estimate of each item of indirect cost—of each item of burden or overhead.
4. The periodic preparation of statements comparing actual with anticipated results.
5. Comparison of actual and anticipated performance, explanation of the variations, and correction of faulty procedures—all by those directly responsible.

The production forecast permits the scheduling of raw material deliveries, the determination of appropriate inventories to insure uninterrupted operation and delivery of finished goods, and should result in tying up a minimum of capital in inventories. To prepare it, reliable data on plant capacity and process yields are essential, and for these the manufacturing manager must rely either upon past experience or upon tests made for the purpose.

All costs fall under one of two headings: those which apply to one operation—direct costs, and those applying to more than one—indirect costs. In order to make possible the automatic analysis by the accounting system of the effect of change in production rate, each separate item, such as labor, repairs, fuel, of both direct and indirect cost, is split into two components: (1) That part

which varies directly as production rate changes, (2) that which varies independent of production rate.

Plant management is not greatly interested in the distribution of indirect costs so that each product or group of products may bear its proportionate share of the total burden, but rather in seeing that the total of these various expenses is reduced to a minimum. The one way to do this is to consider each item of indirect expense in toto—as a separate and distinct entity. For example, it is easier to comprehend and thus to control the cost of supervision when it is considered as a total than after it has been distributed over a half dozen products or processes. In fact, no statement used for plant control should contain any figures resulting from a proration, even though it represent an item of direct cost. Proration of what should be direct costs is frequently rendered necessary due to lack of measuring means—for instance, a common fuel bin or a common steam line supplying two independent operations—but the necessity arises in figuring the cost and not in controlling the consumption of fuel or steam. For the latter purpose the sum of estimated consumptions must be compared with the one actual measurement, otherwise an estimate is being compared with an estimate.

This method of plant management consists first in the clean-cut delegation of responsibility throughout the organization; it entails a forecast or budget of production volume, rate and cost over a suitable period, itemized to correspond with individual responsibility; it entails a parallel record of accomplishment; and finally it furnishes to individuals and groups a statement comparing anticipated and actual results. The whole scheme is directed toward using to the limit the abilities of every employee, making it possible for him to use his initiative and native intelligence to the fullest extent. If the plant is adequately equipped with measuring instruments a foundation is laid for bonus incentives, which usually put a keen edge on those qualities, in the individual and in the group. The standard cost system makes the method workable inasmuch as it automatically separates factors beyond the control of the individual, leaving bare those affected by his judgment and intelligence. Furthermore, it permits detailed routine analysis of great masses of operating data at a minimum of expense.

Predicting Effects of Changes

Insofar as the plant manager is required to play the rôle of economist and to estimate the effect of proposed changes, the raw material for the job is readily available and in excellent arrangement. No matter what the innovation may be, one broad question is invariably presented: how much will the total outgo be affected, and how much the total income? In a large plant, manufacturing a diversity of products, the individual processes are inextricably tied together by their dependence upon mutual facilities and upon mutual labor, supervision, and management. Total cost of increasing or decreasing production from any one process is practically never directly proportional to current volume and cost, as every item of expense, both direct and indirect, may be affected to a different extent and require separate consideration. The effect of such change on any one of the various items of mutual or overhead expense can only be arrived at from consideration of the total of each, and not some portion thereof more or less arbitrarily allotted to the process in question. The plant manager never need concern himself with the distribution of overhead expense; he has before him the tangible cost of each plant activity in its entirety, and he or some member of his force knows the nature of it in detail and can determine the effect of changes in the processing of any item of production.

The value to any one of routine finished costs—costs carried down to individual products or groups of products with all mutual items of direct and indirect expense allocated by a set scheme of proration—is highly debatable. The intricately woven result usually contains so much shoddy in the way of arbitrary assumptions as to make poor fabric for decisions affecting dividends. Possibly better to present every question to a trained economist with the raw material of specific expenditures at his command, and allow him to arrive at an answer after taking into consideration not only plant costs but also general business conditions.

Measuring for Cost Accuracy

Cost systems have always been considered a device of accountants, and insofar as they have failed accurately to reflect the truth, that failure has been laid on the accountant's doorstep. As a matter of fairness it should be stated and emphasized that the plant designer and operator is responsible for the commonest and most important cause of inaccuracy, and for squandering a vast amount of labor in arriving at approximations in place of ascertainable fact. The foundation of any cost system is the accurate measurement of material quantities. Were it possible so to design a plant that all material consumed or produced could be accurately measured, 90 per cent of the design of a cost system is there completed. Nowadays the design of chemical plant equipment, insofar as that design influences the attainment of the desired chemical, physical, and economic result, is most often the work of the chemical engineer; from that point of view, the chemical engineer who designs a plant or an installation must accept the major part of the responsibility for the records which will render possible intelligent operation and control. In other words, he must visualize the economics of each operation for which he designs equipment, and considering the value of each item of consumption or production, provide means to measure it within justifiable limits of accuracy.

Of course, if plants are considered as entities apart from individual processes or pieces of apparatus, most of them are in fact not products of deliberate design. To a greater or less extent they "just grow" to meet changing demands. The possibility of measurement is lost in a maze of old pipe lines, common fuel bins, inadequate tankage, and in faulty instrumentation. In such cases the technical management has effectively removed the underpinnings of the cost system, and they cannot be replaced by proration or estimation.

Thus the chemical engineer, either in the rôle of designer or operator must accept the major part of the criticism now often directed entirely at the cost accountant, and of the engineer that ancient question may well be asked: "And why beholdest thou the mote in thy brother's eye, but considerest not the beam that is in thine own eye?"

Case for Rosin-Wax Sizes

By RAYMOND B. LADOO
Newton, Mass.

FOR MANY generations the act of sizing has been practiced by the paper, textile, cordage, window-shade, leather, and cooperage industries. Usually the primary purpose of sizing is to make the material resistant to the penetration of water, as well as to the action of other liquids, solids, and gases. Another purpose is to increase the stiffness or rigidity. These two sizing operations are combined to give several other resultant functions, such as resistance to aging and weathering, resistance to alkalis, diminishing shrinkage and expansion, and reduction of curling and warping. In the case of paper, an additional function, not directly related to waterproofing and stiffening, is also important: namely, the imparting of proper finish and gloss to the surface.

The more important sizing agents are rosin, starch, glue, casein, and waxes, the first being the most widely used. In recent years, rosin-wax sizes containing several different proportions of wax have become available. These are giving uniformly satisfactory results under virtually all paper mill conditions. This type of size is used in much the same manner as the straight rosin-size. This article discusses the production and advantages of this type of size in particular as applied to paper. These include better sizing with less material and at lower cost, absence of foaming, less brittleness, and better resistance to penetration of alkaline and alcoholic solutions. Wax materially improves the permanency of paper and gives to the product a higher gloss, better printing qualities and an apparent opacity.

Complete Sizing Is Not Necessary

The absorption of moisture or other liquids or gases in either paper or textiles takes place in three ways: namely, on the surface of the individual fibers, within the pores of the fibers, and in the interstices between the fibers. In order really to waterproof or size the finished fabric completely in a durable way it would be necessary to fill the pores of the fibers, coat their surfaces, and fill all the interstices between the individual fibers. Such complete waterproofing or sizing is not necessary nor desirable for fabrics, except in the cases of rubberized cloth for raincoats and waxed paper. For most purposes in paper sizing it is necessary only to coat the fibers with perhaps some degree of impregnation of the pores of the fibers.

In coated papers the surface pores are completely sealed with size and the "valleys" between the fibers are filled with some finely divided solid mineral material. The resultant coating is then rolled or rubbed down to a perfectly flat, smooth, even surface.

In the beater sizing of most papers no attempt is usually made to do more than coat the fibers, either wholly or in part. As a matter of fact just what takes place in the ordinary sizing of paper is not well understood. In most cases it is evident that the pores between the fibers are not filled, as a paper may be well sized and still allow free passage of air. Textiles may be made sufficiently water-repellent to shed water and still have openings large enough to see through. Furthermore, the voids in paper constitute 35 to 60 per cent of the total volume, while the volume of the sizing materials is rarely more than a small fraction of this amount.

What Takes Place?

It is also quite evident that in ordinary paper sizing the fibers cannot be anything like completely coated. Considering the total fiber surface present in paper, the amount of size ordinarily used, and the average particle size of the sizing material, there is rarely more than 5 to 10 per cent enough size to coat completely all the fiber surface.

Perhaps what takes place is this. The pore space in the fibers is largely in the form of capillary tubes which draw moisture into the fibers. If the ends of these tubes are sealed with a water-repellent solid, the absorption of moisture will be greatly retarded and reduced. The amount of size needed to seal the ends of the tubes is far less than that needed to coat the fibers. Capillary action would tend to draw the size particles (in water suspension) into the ends of the tubes. Anything which tends to decrease the particle size of the sizing material and to decrease the viscosity of the size emulsion or suspension at the temperatures used in paper beaters and dryers will theoretically at least, tend to facilitate this drawing in process. This is actually what happens in practice.

During the World War, Germany was cut off from her American sources of rosin, and German papermakers turned to wax for beater sizing. Montan wax was used chiefly. When American rosin again became available at the close of the War, German paper makers largely discontinued the use of wax sizes, as the methods of successful use had then been only partly developed. Both in Germany and in this country, however, experimental work continued so that manufacture and use of rosin-wax sizes were perfected, and commercial use was again extended. Today these wax sizes are widely used in many types of paper to impart certain desirable characteristics.

Waxes must be used in the form of water emulsions. A special technique is required to produce a paraffin wax size that is dependable and safe. In recent years, the technical difficulties have been overcome and now rosin-wax sizes, containing several different proportions of

wax, are readily available, giving uniformly satisfactory results under virtually all mill conditions.

While it is possible to use 100 per cent wax emulsions for sizing, it is common practice to use rosin size mixed with wax emulsions. Rosin-wax sizes are emulsions of wax in rosin soap. In rosin-wax emulsions water is the liquid, rosin soap the emulsifying agent, and a blend of wax and rosin the emulsified material. The particles generally have an average diameter of about 1/20,000 in.

Probably the most widely used rosin-wax sizes are prepared by the Bennett process. While this process was developed primarily for the making of rosin-wax size emulsions, it may be used economically for preparing ordinary rosin size, either neutral or with high or low free rosin content. It may also be utilized in making straight wax emulsions and asphalt emulsions.

This process consists essentially in saponifying and emulsifying in a single operation, through the Bennett dispersion machine, all of the constituents of the size. The mixture of rosin and wax in the proper proportions (or of rosin alone if ordinary rosin size is to be made), called the melt, is loaded into a melting tank and therein heated to a specified temperature. The saponifying agent is made up of an alkaline solution of a definite concentration in a separate heated tank.

Both the melt and the saponifying agent are pumped to separate flow-regulating cups, from which they are fed directly into the top end of the dispersions machine, while the diluting water is introduced through a controlling valve near the bottom end of the dispersion machine. The size comes out of the machine ready to be used in the beaters. Since the temperature and the rate of flow of each of the three ingredients are under accurate control, the physical and chemical characteristics of the finished size can be accurately adjusted and kept uniform.

Concentration of Emulsions

The finished size flows continuously out of the dispersion machine through an adjustable gate, so set that it dams up a small amount of the size, enough to cover the bulb of a recording thermometer. While the temperatures of each of the three ingredients are individually constant, they vary widely. For this reason a small change in the flow of any one ingredient will quickly show up on the recording thermometer.

Rosin-wax emulsions may be made at from 30 to 50 per cent concentration; rosin soaps at any concentration up to 80 per cent or more; asphalt emulsions at any concentration up to 75 per cent. The most commonly used rosin-wax size consists of 81 per cent rosin and 19 per cent paraffin in a 40 per cent concentration emulsion.

Rosin-wax sizes are used in the same manner as straight rosin size in that they are added to the beater in either paste or dilute form and are precipitated with alum. Alum may be furnished to the beater either before or after the rosin-wax size. In most cases it is preferable to add the size first, but under certain circumstances it has been found advisable to reverse this procedure.

The preponderance of evidence indicates that the strength of the paper and the degree of sizing are increased if both the size and alum are furnished as late in the beating period as possible, allowing just sufficient time for the first ingredient added to become thoroughly mixed with the many fibers before adding the second.

As with other sizes, beater temperatures below 120 deg. F. are preferable. Blowing steam into the stock after the size has been added is especially harmful and positively must not be done with rosin-wax sizes. The point at which the steam enters is in the neighborhood of the boiling point, which breaks down the size and causes too coarse flocculation.

Advantages of Rosin-Wax Sizes

1. Rosin-wax sizes give better sizing than straight rosin size with less material used. The particle size of the rosin-wax emulsion is considerably smaller than that of straight rosin size. This means many more size particles with which to coat the fibers, far greater surface per unit of weight, and more uniform distribution through the mass of the fibers.

2. The melting point of the rosin-wax mixture is considerably below that of pure rosin. In passing over the dryers the rosin-wax mixture becomes more fluid than rosin and spreads over a greater area. The higher the percentage of wax the lower the melting point of the rosin-wax blend, and the greater is the covering power of the sizing material.

3. Rosin-wax sizes may be made at a paper mill at less cost than rosin size can be bought. With lower cost, less size used, and less alum needed it is evident that rosin-wax sizes are more economical to use than rosin sizes.

4. Paraffin wax is non-foam producing. It is related to kerosene which is often used as a foam killer in many paper mills. Often the use of rosin-wax size reduces or eliminates foam trouble, but not always, because foam frequently is caused by something other than the size.

5. Wax sizes, even when used in large proportions, do not tend to produce brittleness. For this reason a paper or board may be sized to a high degree and still retain its flexibility. While rosin makes the paper hard and brittle, wax imparts to it a softness and pliability.

6. As wax is not soluble in alkalis and only to a slight extent in alcohol, rosin-wax sizes increase the resistance to penetration of alkaline and alcoholic solutions.

7. The deteriorating action of light and air on rosin sized papers is well known. Such papers on aging turn yellow, become hard and brittle, lose their original finish, strength and sizing. Wax, being practically impervious to air and light, materially improves the permanency of paper products in which it is present.

8. Because wax is subject to a high polish under friction, rosin-wax sizes are of a definite advantage in papers where a high gloss is desired. It has also been found that the presence of even a small per cent of wax in a sheet of paper will tend to lay down the fuzz and to eliminate felt marks, thus giving a smoother surface.

9. Though rosin-wax sizes do not actually increase the opacity of the paper, they confer to the sheet an apparent opacity. Wax-sized papers resist the penetration of printing ink more effectively, the ink pigment being retained on the surface of the sheet. This effect is accomplished without retarding the drying of the ink.

10. Papers or boards sized with rosin-wax sizes do not expand or contract as much as those sized with rosin size. While rosin, when fluxed during the drying process, coats the fibers to a certain extent, wax covers considerably more area and fills better the openings of the pore spaces. Wax thus materially reduces the rate of moisture absorption and loss under varying atmospheric conditions.

11. Curling and warping are due to uneven shrinkage and expansion of the fibers. It can readily be seen that, for the reasons given above, rosin-wax sizes will reduce the tendency of paper and boards to curl and warp.

12. Since wax increases the difference in surface tension between water and the fibers to a greater extent than rosin, rosin-wax sizes are ideal where maximum water-shedding properties are desired.

The writer is indebted to Messrs. Kumler, Lafontaine, and Neitske of the Bennett, Inc. staff for assistance in the preparation of this paper.

OTHERS' VIEWS

Comment and Rejoinder on Tank Heads

To the Editor of Chem. & Met.:

Sir—Many worthwhile points were brought out in the article by C. O. Sandstrom on "Designing Heads for Tanks and Heat Exchangers," which appeared in your December, 1932, issue. There were, however, a number of points, as follows, with which I cannot quite agree:

1. The author mentioned two formulas for the thickness of a bumped head in boiler design. These are:

$$t = 5.5\,P\,L/2\,T + \tfrac{1}{8}\text{ in.}\quad (+\tfrac{1}{8}\text{ in. for manhole})\qquad (1)$$

$$t = 8.33PL/2T\ (+\ 15\text{ per cent but not less than }\tfrac{1}{8}\text{ in. for manhole})\qquad (2)$$

The first, which he calls the "old" formula, he says does not allow for the "knuckle" curve of the head which, however, is allowed for in the second, more up-to-date equation.

While empirical formulas are liable to change styles in accordance with the judgment of the individual observer or experimenter, the fundamental formula for an internal-pressure sphere cannot change. It is based on the reasoning that the internal pressure must be balanced by the cohesion, or tensile strength of the shell. Hence, for a hollow sphere of internal radius L, internal pressure P, shell thickness t, and safe tensile strength T, the force tending to burst the sphere is $\pi L^2 P$, while the cohesive strength (neglecting the slight difference between the internal and external radius of the shell) is $2\,\pi\,L\,t\,T$. For equilibrium $2\,\pi\,L\,t\,T = \pi\,L^2\,P$ or $2\,t\,T = L\,P$ and $t = L\,P/2\,T$. This last is essentially the same as the formulas of Mr. Sandstrom. The coefficients 5.5 and 8.33 are merely rather puzzling factors of safety. The addition of $\tfrac{1}{8}$ in. to the shell thickness is to allow for some internal and external corrosion or scaling. The addition of $\tfrac{1}{8}$ in. for the manhole is indefensible. Certainly the size of the manhole and its type of reinforcement should be taken into consideration.

As far as the knuckle radius is concerned, it is true that stress concentration occurs at sharp turns in bent plates subjected to loads, and that the concentration is somewhat relieved when the turn is provided with an easy fillet. However failure at this point would be due to frequent bendings of the head, resulting from changes in the internal pressure of the vessel and would occur in this region even with a large knuckle curvature.

2. I do not agree that in any cylindrical shell the outside fibers are in tension while the inside fibers are in compression. This is only true before the elastic limit is reached, but in rolling the shell plate to a circular shape a molecular readjustment takes place, leaving the shell plates in no worse condition structurally than they were before rolling.

3. Mr. Sandstrom's suggestion of using staybolts to prevent bulging of the heads in heat exchangers sounds interesting. The only objection I have is that the bolts would be too long and would elongate under the pressure. There might also be trouble due to differential expansion between the staybolts and the shell. Another objection is that it would be difficult to keep the liquid in the heads from leaking through the threads of the staybolts.

BERNARD KRAMER.

Mechanical Engineer,
Pittsburgh, Pa.

Mr. Sandstrom's Reply

To the Editor of Chem. & Met.:

Sir—I shall reply to Mr. Kramer in the topical order of his discussion.

1. In the first place I am not responsible for the formulas submitted for the design of heads. The "old" formula was in the boiler code of the A.S.M.E. for many years. As the years went by, the defects of the old head became manifest and the "new" formula was borrowed from the Massachusetts boiler code. A still better head is the "elliptical" head, the use of which is optional.

The old formula was intended to provide for the small knuckle radius. After allowing a factor of safety of 5.5 in the formula for a sphere, there is added $\tfrac{1}{8}$ in. to the thickness to allow for the departure from a true sphere. Such an addition to allow for corrosion would be a bit inconsistent as no such allowance is made in the thickness of the shell.

Mr. Kramer states that, under changing pressure, failure would occur in the knuckle curve even with a large knuckle curvature. The purpose of the large radius at the knuckle is to keep the stress at that place within the elastic limit, or endurance limit, of the material; and if this be done the head will withstand any number of flexings—certainly within the useful life of the apparatus.

2. If cold working does not set up stresses and strains in steel then the present concern about over-strained areas is unnecessary. The temperature of the fluid in some pressure vessels probably has an annealing effect but this does not seem to be depended upon by manufacturers, who show a tendency toward annealing the entire vessel to relieve cold-working strains.

3. The bolts, when set up with the wrench, are under a certain stress and elongation. When the fluid pressure is applied it has no effect on the bolt unless the total pressure on the area carried by the bolt exceeds the initial, or tightening force. You see, the bolt, or rod, is much more yielding than the gasket and the bearing surfaces.

The worst case of differential expansion would occur when the hottest fluid passes through the tubes, with no cooling fluid passing around the tubes. The bolt then would reach its highest temperature and lengthen according to the temperature rise. But the tubes also lengthen and produce a tensile force in the shell with a corresponding elongation. The shell becomes heated by radiation and the resulting elongation is added. The elasticity of the gaskets supplements the elongations and the expansion of the bolt is compensated. Bear in mind that the elongation of a 48-inch steel rod with a temperature rise of 200 deg. F. is only $\tfrac{1}{16}$ inch.

The cap nut prevents leakage of the fluid past the threads of the bolt. Ordinarily a gasket or washer is used between the nut and the cover, but spot-facing the cover, and facing the nut is sufficient to prevent leakage, as the bearing pressure is very high.

C. O. SANDSTROM.

Thermal Engineering Co.
Los Angeles, Calif.

Correction—The address of the Nukem Products Corp., makers of Basolite, is Buffalo, N. Y. It was incorrectly given on page 655 of the December, 1932, number.

BOOKSHELF

Technocratic Facts and Fancies

WHAT IS TECHNOCRACY? By *Allen Raymond.* McGraw-Hill Book Co., Whittlesey House Division, New York, 1933. 180 pages. Price, $1.50.

ON JAN. 23 TECHNOCRACY, so far as the world knew, was a thriving movement, thundering its prophecies across the land. On the 24th it was rent by its own thunder and with two or three final spasms in the daily press, the world lost interest. Today, it is to be feared, Technocracy is "just another one of those things" for the man in the street, just another "white rabbit" as they say in Washington. Which, in a way, is unfortunate, for it is in great waves of popular enthusiasm that worthwhile social evolution sometimes comes about. For all the exaggeration, the overstatement and misstatement, the demagogic type of appeal, Technocracy and its tenets contain more than a germ of truth which it would be a pity to let die. If any good is to come of what has already been accomplished, more engineers than the few who remain in the sundered technocratic groups should take it upon themselves to carry on the study. For it becomes increasingly evident that the solution to the problems raised by mechanization will not spring full-blown and unaided from the brow of some political Jove. To this reviewer, at least, it seems equally clear that what the engineers have started they must help to finish.

To one who has attempted to struggle through tons of near-technocratic slush, Mr. Raymond's book is nothing less than a wind-fall. Straight reporting that it is, it is none the less a careful, thoughtful, and thought-provoking job which has concerned itself not only with the ideas of the movement but with the men involved, their backgrounds and the history of their ideas. A knowledge of "What Is Technocracy" should be part of the stock in trade of every engineer who admits to himself his part in the responsibility for the impact of technology on today's social structure.

Liquefied Petroleum Gases

HANDBOOK OF BUTANE-PROPANE GASES. Edited by *George H. Finley* and published by Western Gas, 124 West 4th St., Los Angeles, Calif. 279 pages. Price, $5.

Reviewed by *R. S. McBride*

SUMMARIZING various phases of this "baby" fuel industry which supplies propane and butane, various authors have contributed twelve chapters to this handbook. It also includes a summary of a trade catalog section of advertisements of equipment and supply firms in this industry. The subjects treated include a history of the development, physical properties of liquefied petroleum gases and their mixtures, analytical methods, production methods, transportation, use with manufactured gas, use for butane-air gas, use for undiluted-vapor city distribution, use as an industrial plant fuel, appliances, and bottled-gas distribution. Well informed specialists contribute most of the chapters; but the book lacks the authoritativeness which might have been achieved by indicating the original sources from which technical and scientific information has been drawn. In this regard this reviewer feels that it is notably lacking in giving real credit to some of the important pioneers, both companies and individuals. Despite this limitation it affords the most comprehensive reference work thus far available on the propane-butane industry.

A Picture of American Industry

THE DEVELOPMENT OF AMERICAN INDUSTRIES. By *John George Glover* and *William Bouck Cornell.* Prentice-Hall, Inc., New York. 932 pages. Price, $6.

Reviewed by *Lawrence W. Bass*

THIS SYMPOSIUM, planned primarily as a text for schools of commerce and business administration, contains 39 chapters devoted to our major industries as well as chapters on labor and on trade associations. Process industries included are: Pulp and paper, rubber, leather, sugar, petroleum, glass, cement, chemicals, and paint, varnish, and lacquer; metallurgical industries: iron and steel, copper, lead, and zinc. The discussion of the food industries, aside from agriculture, is limited to meat packing, fishing, and sugar—a rather unbalanced diet. The broad scope of the book is indicated by the inclusion of chapters on book publishing, newspapers, retailing, hotels, and banking.

Each industry is discussed according to the following general plan: early history, growth, geographic location, raw materials, manufacturing methods, important products, marketing, financing, labor, company organization, important companies, legislation, and possible future developments. The individual chapters were contributed by company or trade association representatives.

This comprehensive work should be invaluable in giving the student a general introduction to the business world. A detailed treatment of a major industry, however, is not to be expected in the space of 25 pages; the expert will need to search elsewhere for a thorough discussion of his subject, but he will find here much to interest him in other fields.

The Nitrogen Situation

THE SIGNIFICANCE OF NITROGEN. By *J. Enrique Zanetti,* with introduction by *Francis P. Garvan.* The Chemical Foundation, Inc., New York. 101 pages.

MOST chemical engineers and industrialists who have waited for this long-heralded report on the nitrogen situation were probably disappointed when they found that Professor Zanetti had confined his book to a non-technical, historical review of facts already well-known to the industry. But in so doing they overlook the more important consideration, namely, that this little book is addressed to the layman and its sole purpose is to put before the American public the story of an amazing chemical and industrial development in this country. If knowledge so presented can filter into the Halls of Congress and register even a few of the most elementary facts about the domestic nitrogen industry, the purposes of the Chemical Foundation will have been justified. But having accomplished that, Professor Zanetti has a further obligation to discharge. His trip to Chile and the months he spent in investigation in this country must have given him a much more intimate and authoritative viewpoint than is reflected in these pages. In the interest of technical progress, he should now render an economic and engineering report directly to the chemical industry and profession.

The "Black Art" Abroad

DIE KÜNSTLICHEN KOHLEN FÜR ELEKTRISCHE ÖFEN, ELEKTROLYSE UND ELEKTROTECHNIK. Second Edition. By *Kurt Arndt.* Verlag von Julius Springer, Berlin. 336 pages. Price, 38 M.

Reviewed by *C. L. Mantell*

THIS VOLUME covers in considerable detail the manufacture of carbon electrodes for electrothermic and electrolytic work as well as miscellaneous uses such as those of arc lamps, batteries and resistance carbon. The method of treatment is the same as that of the reviewer's series of articles "The Technology of the Carbon Electrode Industry" (*Chem. & Met.*, Vol. 27, No. 8, 1922) and the electrode section of Mantell's "Industrial Carbon" from which

Arndt quotes freely and from which he has taken more than a dozen illustrations. Arndt's treatment is more detailed. The value in this connection of a 30-page section on microscopes and photography is questionable. The uses of electrodes are briefly touched on. Much detail is given for testing methods. Among the illustrations are some good micrographs of various carbons. The book abounds in good illustrations, there being 365 spread over 336 pages of text. It will appeal strongly to the small group engaged in the manufacture of carbon articles, particularly for the data on European manufacturing practice.

Correction

The Silver Anniversary pamphlet of the American Institute of Chemical Engineers was reported in these columns in December as generally available from the office of the Secretary, in the Bellevue Court Building, Philadelphia, at fifty cents per copy. This was not entirely correct. That price applies only to members of the Institute; for non-members the charge is one dollar.

Oxidation as an Industrial Process

CATALYTIC OXIDATION OF ORGANIC COMPOUNDS IN THE VAPOR PHASE. By *L. F. Marek* and *Dorothy A. Hahn*. American Chemical Society Monograph Series No. 61. Chemical Catalog Co., Inc., 330 W. 42d St., New York, 1932. 428 pages. Price, $9.

Reviewed by *P. H. Groggins*

ALTHOUGH OXIDATION is one of the commonest of known reactions and is widely used as a source of energy, it is only within the past century that concerted efforts have been made to study individual reactions systematically and to apply this knowledge in the exploitation of new industrial processes.

The necessity for compiling and organizing the rapidly developed literature on catalytic oxidation in the vapor phase has been apparent to students and workers interested in this subject. This work contains 1,285 references and covers in a comprehensive manner the oxidation processes involved in the preparation and utilization of paraffin hydrocarbons, aliphatic alcohols, aldehydes, and acids, as well as diverse and important aromatic compounds.

The chapters dealing with the cause and suppression of knocking in internal combustion engines should prove to be an instructive review for chemists and engineers interested in this field. The three chapters dealing with the oxidation of benzene, naphthalene, and anthracene constitute an excellent review of the published literature. Here, owing to the difficulties in obtaining industrial cooperation, it has been necessary for the authors to rely largely on disclosures in patents.

In their introductory chapter, the authors have presented a complete summary of the theoretical and practical aspects of catalysis. This discriminating review is of great value in interpreting and evaluating the subsequent reactions. The concluding chapter contains a valuable review of the apparatus employed in catalytic oxidations in the vapor phase. Numerous illustrations serve as a vehicle for a practical analysis of methods of effecting catalysis and means for controlling the conditions of reaction. This discussion should prove of interest to workers in all branches of organic synthesis.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Drum Specifications. New specifications of the Federal Specifications Board on: Drums, steel, type 6D (for inflammable solids or oxidizing materials), single-trip container, RR-D-746; Drums, steel, type 6C (for inflammable solids or oxidizing materials), RR-D-741; Drums, steel, type 5 (for inflammable or poisonous liquids), RR-D-726.

Statistics Concerning Intoxicating Liquors, December, 1932. Bureau of Industrial Alcohol; 10 cents. Statistics for the fiscal year ended June 30, 1932.

Chemical Utilization of Wood, by Henry K. Benson. Department of Commerce, National Committee on Wood Utilization; 15 cents.

Wages and Hours of Labor in the Manufacture of Silk and Rayon Goods, 1931. Department of Labor, Bureau of Labor Statistics Bulletin No. 568; 10 cents.

Leather in the British Empire, by J. G. Schnitzer. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 140; 10 cents.

The Silver Market, by Herbert M. Bratter. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 139; 10 cents.

Report V of the Federal Oil Conservation Board to the President of the United States, October, 1932; $1.00 (cloth).

American Cypress and Its Uses. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 141; 5 cents. Includes information on use in tankage and for other plant applications.

Impinger Dust Sampling Apparatus Used by the U. S. Public Health Service, by Leonard Greenburg and J. J. Bloomfield. Reprint No. 1528 from Public Health Reports; 5 cents.

Index of Analyses of Natural Waters in the U. S. 1926 to 1931, by W. D. Collins and C. S. Howard. Geological Survey, Water-Supply Paper 659-C; 5 cents.

Statistical Abstract of the United States, 1932. Bureau of Foreign and Domestic Commerce. 826 pages. Pertinent statistics from state and private sources bearing on the industrial, commercial, and social life of this country; $1.25.

Manufacturing Market Statistics, by Charles B. Eliot. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series No. 67; $1.00.

Rules of Practice and Procedure and Laws Relating to the U. S. Tariff Commission. Tariff Commission Miscellaneous Series; 5 cents.

Subject Index of Tariff Commission Publications. Revised September, 1932.

Depreciated Exchange. Tariff Commission Report No. 44, Second Series. Discussing effect on imports, exports, and ad valorem equivalents of specific rates of duty.

Publications on Glass Technology and Standard Samples of Interest to the Glass Industry. Bureau of Standards Letter Circular 350; mimeographed.

Mineral Production of Alaska in 1932. Department of the Interior Release of Jan. 1, 1933; mimeographed.

Statistical Microscopic Examination of Mill Products of the Copper Queen Concentrator, of the Phelps Dodge Corp., Bisbee, Ariz., by R. E. Head and others. Bureau of Mines Technical Paper 533; 5 cents.

Laboratory Testing of the Inflammability of Coal and Other Dusts Conducted by the Bureau of Mines, by H. P. Greenwald. Bureau of Mines Bulletin 365; 10 cents.

Ore Concentration and Consumption of Flotation Reagents in 1931. Bureau of Mines Mineral Market Report No. M.M.S. 174; mimeographed.

Economics of Potash Recovery From Wyomingite and Alunite, by J. R. Thoenen. Bureau of Mines Report of Investigations 3190; mimeographed.

Character of Drainage From Mines in the Thick Freeport Coal Bed, Pennsylvania, by R. D. Leitch and others. Bureau of Mines Report of Investigations 3193; mimeographed.

Composition of the Fractions of Primary and High-Temperature Tar, by E. B. Kester and W. D. Pohle. Bureau of Mines Report of Investigations 3197; mimeographed.

Survey of Fuel Consumption at Refineries in 1931, by G. R. Hopkins. Bureau of Mines Report of Investigations 3198; mimeographed.

Mineral Production Statistics for 1931—Separate pamphlets from Bureau of Mines on: Manganese and Manganiferous Ores, by R. H. Ridgway, 5 cents; Lead and Zinc Pigments and Salts, by E. W. Pehrson, 5 cents; Mercury, by P. M. Tyler and H. M. Meyer, 5 cents; Vanadium, Uranium and Radium, by F. L. Hess, 5 cents; Feldspar, by H. H. Hughes and Jefferson Middleton, 5 cents; Cobalt, Molybdenum, Tantalum, and Titanium, by P. M. Tyler and A. V. Petar, 5 cents; Silica, by E. R. Phillips, 5 cents; Platinum and Allied Metals, by H. W. Davis, 5 cents; Asbestos, by Oliver Bowles and B. H. Stoddard, 5 cents; Iron Ore, Pig Iron, and Steel, by H. W. Davis, 5 cents; Chromite, by L. A. Smith, 5 cents.

Mineral Production of the World, 1924-1929, by L. M. Jones. Bureau of Mines; 10 cents. A Statistical summary which will supplement the 1930 Mineral Resource Series.

Mineral Production Statistics for 1932—summaries by commodities in preliminary estimate form are now available, including: Lead; slate; iron ore; zinc; copper; copper, lead; and zinc mining; manganese ore.

Production Statistics From 1931 Census of Manufactures in preliminary mimeographed form for all commodities, including recent reports on: Adhesives; aluminum compounds and alums; beverages; blacking, stains, and dressing; bluing; bone black, carbon black, and lampblack; candles; chemicals; drug grinding; essential oils; ethyl alcohol and distilled liquors; fireworks; graphite, ground and refined; nitrogen and fixed-nitrogen compounds; oils not elsewhere classified; oleomargarine and other margarines; paving materials; photographic apparatus and materials and projection apparatus; potassium compounds; salt; steel-works and rolling-mill products; vinous liquors; chemicals; miscellaneous leather products; paper and paper board; coke oven products; concrete products; turpentine and rosin; minerals and earths, ground or otherwise treated; lubricating oil; cement; manufactured gas; miscellaneous chemicals; coal tar products; cottonseed oil, cake and meal; canning and preserving fish; flour and other grain-mill products; cheese; prepared feeds for animals and fowls; vinegar and cider; meat packing, wholesale; bakery products; chemicals; condensed and evaporated milk; summary by industries; and others.

Distribution of Sales of Manufacturing Plants: 1929. Bureau of Census Distribution No. IG-202; 15 cents.

PLANT NOTEBOOK

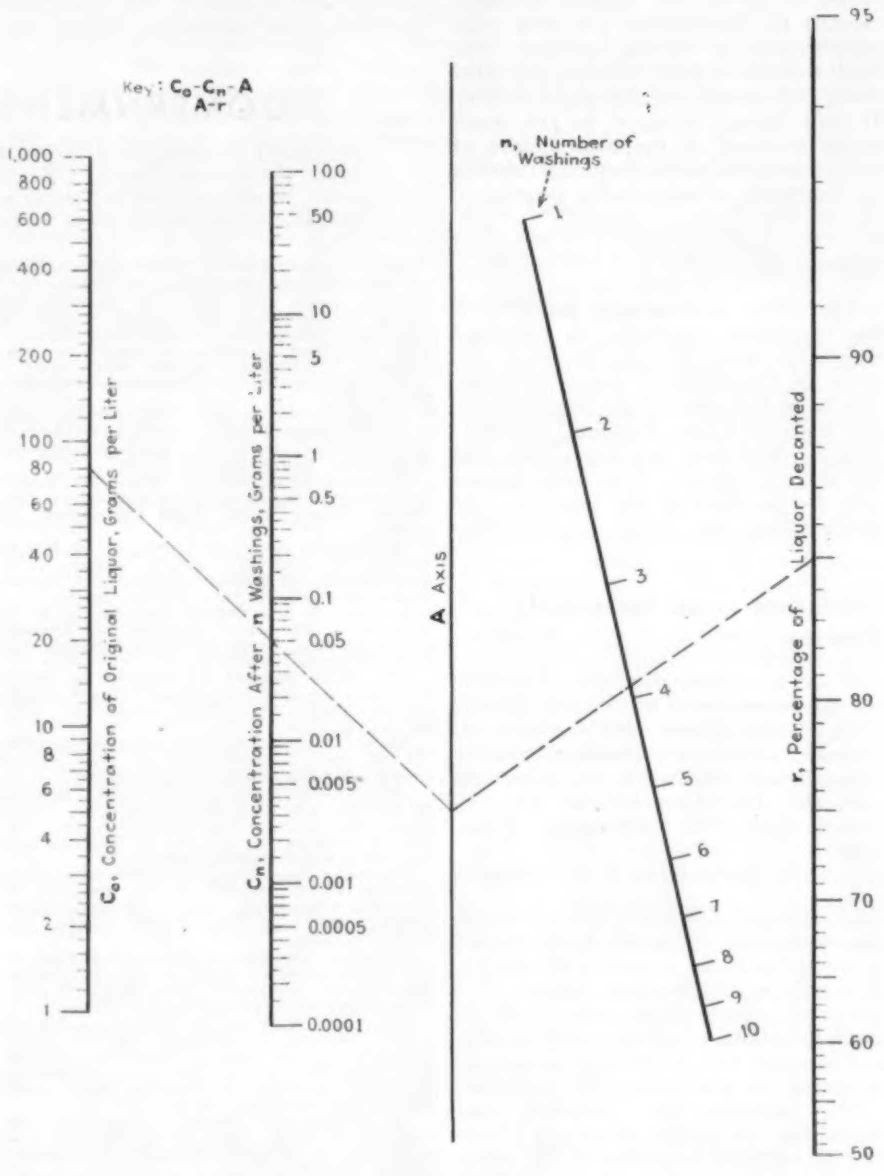
Nomographic Solution of Sludge Washing

By D. S. DAVIS
Dale S. Davis' Associates
East Northfield, Mass.

METHODS of essentially a decantation nature are frequently employed both in the plant and in the laboratory for the washing of sludges and precipitates. In either case, efficient control involves a somewhat troublesome calculation which can be best performed by means of the accompanying alignment chart, based upon the following considerations.

Let C_o = the concentration of the original supernatant liquor.
and r = the percentage of the total volume which is decanted each time.
Then $100 - r$ = the percentage of the total volume remaining each time.

C_1, the concentration after the first washing, is evidently equal to $\left(\frac{100-r}{100}\right)$ C_o and C_2, the concentration after the second washing $= \left(\frac{100-r}{100}\right) C_1 = \left(\frac{100-r}{100}\right)^2 C_o$. The concentration after n washings, C_n, will then equal $\left(\frac{100-r}{100}\right)^n C_o$.



The use of the chart is illustrated as follows:

Example (1). How many washings are required in order to reduce the concentration of liquor from 80 grams per liter to less than 0.05 gram per liter if it is possible to decant 85 per cent of the liquor each time? As shown by the key, connect 80 on the C_o scale with 0.05 on the C_n scale and continue the line to the A-axis. Connect the latter intersection with 85 on the r scale and note that the latter index line crosses the n scale between values of 3 and 4, indicating the need for 4 washings.

Example (2). A sludge is washed five times with volumes of water equal to 70 per cent of the volume of the original liquor and sludge. If the initial concentration of dissolved matter was 62 grams per liter what will be the concentration in the final wash water? Connect 70 on the r scale with 5 on the n scale and continue the line to the A axis. Connect this latter intersection with 62 on the C_o scale and read the desired value as 0.15 gram per liter on the C_n scale. The index lines for Example (2) are not shown on the chart.

Gaging High Tanks

A simple method of attaching gage glasses to tanks of considerable height was described in a recent issue of *Oil and Gas Journal*. The purpose was to develop a method for gaging gasoline tanks without hazard or vapor loss. The same method, however, seems suitable for tanks of other sorts and avoids some of the difficulties encountered in attaching overlapping glasses, each one of which is usually connected at each end to the tank. In the method described a 1-in. pipe line constructed of tees and nipples is connected to the top and bottom of the tank with ells, nipples and tank flanges. In this riser, at intervals depending on the lengths of ordinary boiler gage glass available, are tees into which are screwed street ells to support the glasses. The latter are attached with ordinary boiler-gage glands. To present a continuous view of the level, of course, adjacent glasses must overlap as in conventional practice.

NEW EQUIPMENT

Centrifugal Ball Mill • Induction Separator • Acid-Proof Belts • Motorized Reducer • Magnetic Vibrators Sieves and Screens • Corrosion-Resisting Chain • New Type Kiln Mill • New Welding Torch • Miniature Steam Generators • Improved Steam Engines • Midget Banbury • Dust Helmet • Non-Skid Belt • Industrial Locomotives • Portable Electrical Instruments • Long-Lever Trap • Axial-Flow Pumps • Vacuum Refrigerating Unit • Portable Pipe Cutter • Mobile Drum Hoist High-Ratio Reducers • Round-Chart Recorder • Portable Air Unloader • Manufacturers Publications

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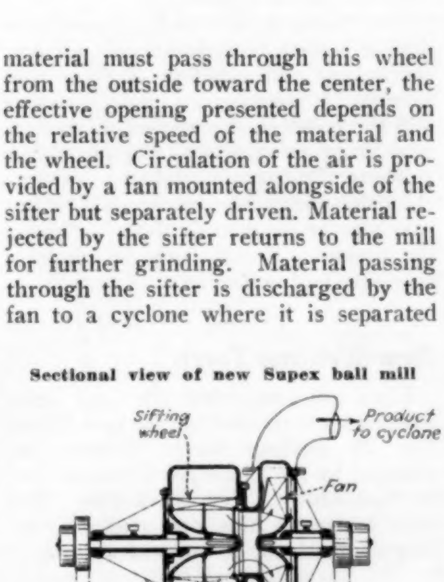
Centrifugal Ball Mill

Supex Equipment Co., 139 Charles St., New York City, has recently introduced an air-separation ball mill of entirely novel design. It is said to be capable of grinding in one continuous operation both hard and soft substances such as dyes, earth colors, iron oxides, minerals and other chemical products, reducing them to any fineness to 330 mesh. This fineness is readily adjustable within wide limits. Once adjusted, it is said to be independent of the quantity of material passing through the mill and the wear on the grinding elements. Power consumption is claimed to be remarkably small. Operation is said to be dust-free and comparatively noiseless.

The accompanying drawing shows the construction of the mill. The balls are contained in a circular grinding chamber consisting of a stationary grinding ring and revolving bowl. Material is fed continuously into the bowl where it is thrown by centrifugal force, together with the balls, against the grinding ring, which then throws balls and material back into the bowl. A continuous air circulation sweeps down into the bowl, picking up the fine material and carrying it to a centrifugal sifter of novel design. This consists of a multi-blade fan wheel rotating at high speed. Since material must pass through this wheel from the outside toward the center, the effective opening presented depends on the relative speed of the material and the wheel. Circulation of the air is provided by a fan mounted alongside of the sifter but separately driven. Material rejected by the sifter returns to the mill for further grinding. Material passing through the sifter is discharged by the fan to a cyclone where it is separated from the conveying air which then returns to the mill. To adjust the size of finished product, it is only necessary to alter the speed of the sifting wheel. The sifter is also sold separately.

Sectional view of new Supex ball mill



Induction Separator

To meet new purity requirements in the manufacture of artificial abrasives and refractories, the Exolon Co., Blasdell, N. Y., developed the Johnson induction magnetic separator which operates by feeding the material in granular form and in a constant stream down a chute and over a series of rotors energized by induction and revolving in a magnetic field. Each rotor causes the more highly magnetic particles to cling to its surface slightly longer than the non-magnetic. When the rotor releases the material passing over it, the particles which have clung to the rotor a fraction of a second longer take a different arc and are consequently separated from the more faintly magnetic material. Material not affected passes over succeeding rotors of greater magnetic power where the process is repeated.

The Johnson separator is said to be capable of continuous operation and extremely high flux density without heating and with very low current consumption. It is claimed that the design permits operation in dry, dusty atmospheres with minimum maintenance cost. The separator is recommended for use in ceramic plants and by producers of non-metallic minerals such as bauxite, fluorspar, kyanite, barite, and so on.

Acidproof Belts

B. F. Goodrich Rubber Co., Akron, Ohio, has announced the development of rubber belting which is claimed to be highly resistant to the action of acids, alkalis and oils. The new belting is said to have given satisfactory service after complete immersion in oil for several days.

Motorized Reducer

D. O. James Mfg. Co., 1114 West Monroe St., Chicago, Ill., has recently announced a new combination of motor and speed reducer available in sizes from 0.5 to 20 hp., with a wide range of ratios and speeds. The gears are of continuous-tooth herringbone construction, mounted on anti-friction bearings and running in a bath of oil.

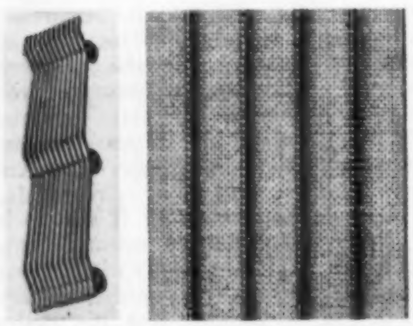
Magnetic Vibrators

Electro-magnetic vibrators, comprising a complete line, have been put on the market by the Syntron Co., Pittsburgh, Pa. These vibrators consist of a

coil-wound horeshoe magnet and armature, the latter being held away from the yoke of the magnet by heavy springs which maintain the air gap. These vibrators operate on a half-wave pulsating current produced by an electronic valve by a method patented by this company. The vibrators are made in various sizes for applications of all sorts.

Sieves and Screens

Abbe Engineering Co., 50 Church St., New York City, has introduced three new types of screen, two of which, the "Rima" wound-wedge-wire slit sieve and the "Streno" reinforced screen, are shown in accompanying illustrations. The strips used in the former may be obtained in a wide variety of profiles



Left: Stepped "Rima" sieve; right: "Streno" wire cloth

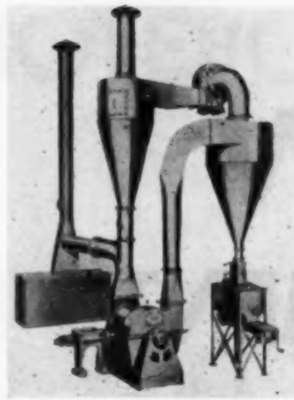
and are assembled flat or in the stepped form shown. The supporting bars may be either inside or outside the sieve. This equipment is available with slits from 1/500th of an inch in width, up. Such sieves are made in all metals and in all shapes, including round and hexagonal drums.

The second type, "Streno" cloth, is made in meshes from 18 to 120, in phosphor-bronze and steel. It is used for filter drums, vibrating, shaking and rotary screens and other similar applications and has as a special feature, reinforcing wires spaced at intervals which are said greatly to increase its life.

"Vibro" screen, the third type, is made of spring steel and is a lightweight screening cloth for use on vibrating screens and similar applications. It is made in meshes from $\frac{1}{8}$th in. to 60.

Corrosion-Resisting Chain

Roller chain supplied with special corrosion-resisting side links has been put on the market by the Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., under the name of "Silverlink." Features of the chain include heat-treated alloy-steel side bars, nickel-steel case-hardened pins, and alloy-steel heat-treated rollers. Sizes range from $\frac{1}{2}$ to $2\frac{1}{2}$ in. pitch.



Improved Raymond kiln mill

New-Type Kiln Mill

Improvements in its kiln-mill method of combined drying and grinding are announced by Raymond Bros. Impact Pulverizer Co., 1311 North Branch St., Chicago, Ill. An accompanying view shows the new unit which is built entirely of stainless steel to permit the handling of corrosive materials. It consists of an impact-type mill with automatic feeding device and air separation system including a cyclone collector for receiving the finished product, a concentrator collector for cleaning the venting air of superfine dust, a main exhauster, a vent fan and a heater fired with oil, gas or coke.

The device is said to be adaptable to a wide variety of applications including the drying and grinding of clays containing 15 per cent or more moisture and the removal of water of crystallization as in grinding and drying copper sulphate, calcium sulphate, calcium chloride and other materials. Filter cake may be fed directly to the mill from the presses. Certain organic products may also be handled by this method.

New Welding Torch

High efficiency and low gas consumption are claimed for the new Purox No. 28 welding torch recently announced by the Linde Air Products Co., 30 East 42d St., New York City. Ten interchangeable tips are available, fitting the torch for all sorts of welding.

Miniature Steam Generators

Following the announcement in the October, 1932, equipment pages of *Chem. & Met.*, of its new line of electric steam generators, the Commonwealth Electric & Mfg. Co., 83 Boston St., Boston, Mass., has developed four miniature steam generators, electrically heated in sizes of 2, 3, 4, and 5 kw. corresponding to 6, 9, 12 and 15 lb. of steam per hour. The generators are suitable for pressures up to 100 lb.

Improved Steam Engines

Troy Engine & Machine Co., Troy, Pa., announces a number of improvements in its line of vertical steam engines. The most important of these is the new "watershed" partition between the cylinder and crankcase which is used in the Troy-Engberg Type E engine. Without introducing wear into the operating mechanism, this partition nevertheless prevents water from the cylinder from reaching the oil reservoir, while at the same time it prevents lubricating oil from following the piston rod to the top of the watershed where it would escape into the drain. The company is prepared to furnish single-cylinder engines in sizes to 225 hp. and duplex engines up to 450 hp. in both vertical and horizontal types.

Midget Banbury

For experimental work on rubber, asphaltic materials, phenolic condensation products, and so on, in smaller capacities than possible in existing laboratory models, Farrell-Birmingham Co., Ansonia, Conn., has introduced a midget-size Banbury mixer of 90-150 grams capacity. Mounted on the rotor shafts are rolls for sheeting the stock after mixing. These rotors are said to be exact duplicates of those used in large commercial machines.

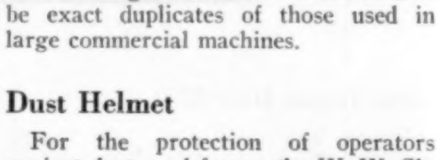
Dust Helmet

For the protection of operators against dusts and fumes, the W. W. Sly Mfg. Co., Train Ave., Cleveland, Ohio, has recently announced the "Purair" helmet which is very light in weight and is carried from a sweat-band around the head. The helmet fits closely over the shoulders which support a considerable part of its weight. It is constructed with an aluminum frame and a rubber hood made by the anode process. Air is supplied through a filter from a compressed-air line or by means of a blower offered by this company.

Non-Skid Belt

Applying the same principle as that of the non-skid automobile tire, E. F. Houghton & Co., Third, American and Somerset Sts., Philadelphia, Pa., has developed what is called the "VimTred"

Section of Vim Tred Belt



leather belt. The non-skid surface is produced by pressing down or indenting parts of the surface of the belt, so as to concentrate the pressure between the belt and the pulley on the ribbed tread and hence, according to the claims of the manufacturers, to increase the gripping power of the belt. The tread surface reduces the contact area by 50 per cent and hence is said to double the contact tension without changing the total tension. The result is said to be greater pulling power and longer belt life.

Industrial Locomotives

According to a recent announcement, the Brookville Locomotive Co., Brookville, Pa., is now supplying industrial locomotives with tractor power plants in sizes from 5 to 12 tons weight. The company's products now include a complete series of industrial locomotives equipped with "Caterpillar" engines. Four operating speeds are offered in both forward and reverse with a range of approximately to 2 to 15 m.p.h.

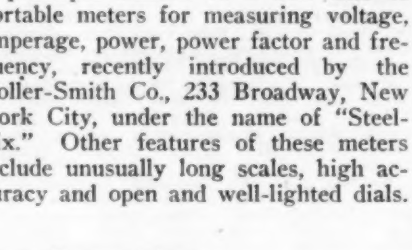
Portable Electrical Instruments

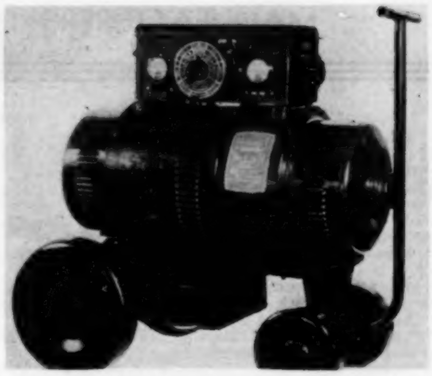
Steel cases, shielding the mechanism from external magnetic influences, are a principal feature of a new line of portable meters for measuring voltage, amperage, power, power factor and frequency, recently introduced by the Roller-Smith Co., 233 Broadway, New York City, under the name of "Steel-Six." Other features of these meters include unusually long scales, high accuracy and open and well-lighted dials.

Long-Lever Trap

What is described by its maker, the Bundy Steam Trap Co., Nashua, N. H., as a mechanical thermostatic trap, is shown in an accompanying cross-sectional view. Annular openings in the false bottom vent air and condensate while steam passes through the center opening into the bucket. The presence of steam causes the bucket to float and closes the valve. As the steam condenses the bucket sinks, opening the valve. This construction is said to give instantaneous opening and closing which, combined with the special design of valve, eliminates wiredrawing.

Bundy Junior Trap



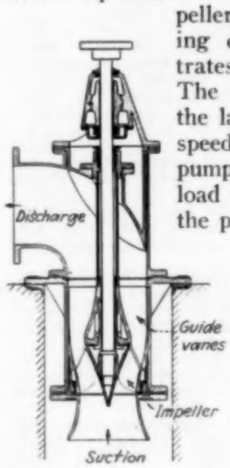


Improved Electric Welder

Increased capacity of 60 per cent is a feature of this new portable arc welder brought out by Hobart Bros. Co., Troy, Ohio. The equipment is designed for handling both coated and plain rods. It is equipped for remote control, permitting the operator to weld 50 to 100 ft. away from the welder and still have complete control of the welding current.

Axial-Flow Pumps

In order to combine the best features of centrifugal volute-type pumps and the propeller type, Foster Wheeler Corp., 165 Broadway, New York City, has developed a new form of axial-flow pump which combines a propeller-like, streamlined impeller with a series of discharge guide veins to convert the high flow velocity to static pressure and direct the flow parallel to the axis of the impeller. The accompanying cross-section illustrates the construction. The pump has neither the large size and slow speed of the volute-type pump, nor the poor no-load characteristics of the propeller pump. Its high speed permits the use of a small motor while its no-delivery power consumption is only slightly more than half the maximum. It can be used in either a horizontal or a vertical position, handling up to 40,000 gal. of water per minute against a total head as high as 30 ft.



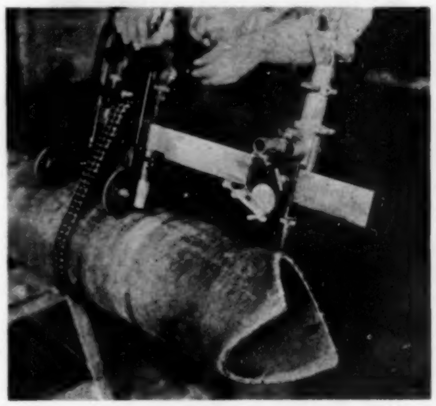
Cross-section of axial-flow pump

Vacuum Refrigeration Unit

For moderate-temperature refrigeration, Ross Heater & Mfg. Co., Buffalo, N. Y., has developed a line of steam-jet-operated vacuum refrigerating units available in standard sizes from 3 to 400 tons of refrigeration per 24-hour day. The units are suitable for chilling water to temperatures of 35 to 70 deg. F. They consist of an evaporator into which the water to be cooled is sprayed and from which the cooled water is withdrawn, evacuated by means of a primary steam ejector which discharges to a primary condenser. Air is vented by means of secondary ejectors discharging to inter and after condensers.

Portable Pipe Cutter

An accompanying view shows a new portable pipe cutting and beveling machine, developed by the Air Reduction Sales Co., Lincoln Building, New York City, and designated Airco Style 1. The machine comprises a light four-wheel carriage to which are attached a crank-driven chain sprocket and a torch-supporting bracket. The carriage is held against the pipe by a roller chain. The torch is moved lengthwise or around the pipe by hand control. It may be set at an angle to bevel the pipe for subsequent welding and is useful for cutting the pipe into special shapes required in pipe fabrication.



Pipe cutter in action

Mobile Drum Hoist

Combining its "Cyclone" wire-rope hoist with a geared structural carriage, Chisholm-Moore Hoist Corp., North Tonawanda, N. Y., has developed a new mobile, hand-operated mechanism for use where headroom is limited and maximum lift is required. Capacities range from 3 to 30 tons. Dual chains serve for hand operation, one for heavy and one for light loads. Another hand chain is used to move the hoist on its rails.

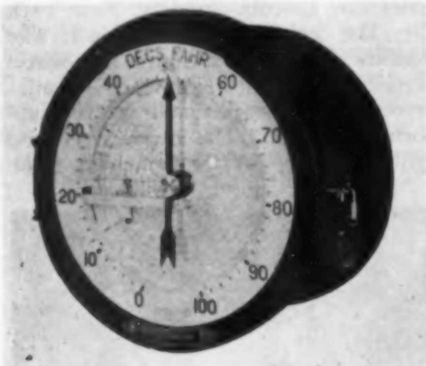
High-Ratio Reducers

New double-reduction worm gears recently developed by the DeLaval Steam Turbine Co., Trenton, N. J., employ separate housings for the two reduction stages to permit considerable flexibility

in the arrangement of the drive. One type has both high- and low-speed shafts horizontal, while the other has a horizontal high-speed shaft and vertical low-speed shaft. In either type the shafts may extend in one or the other or both directions.

Round-Chart Recorder

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., has announced the development of a new round-chart Micromax indicating recorder which is shown in the accompany view. The



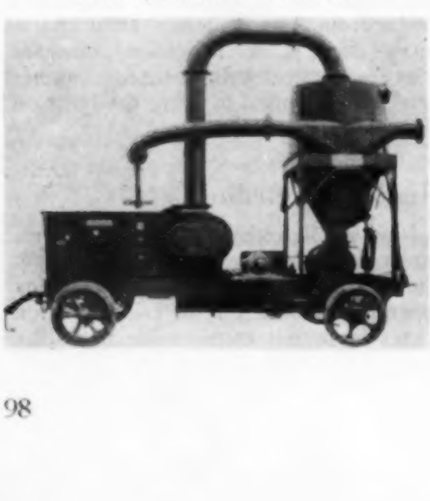
New round-chart Micromax

mechanism is an adaptation of the Micromax self-balancing potentiometer mechanism described in the October, 1931, issue of *Chem. & Met.* The particular feature of the new recorder is the open indicating scale and large indicating pointer.

Portable Air Unloader

Unloading of ships to box cars placed adjacent to the unloading equipment, at the rate of about 60 tons per hour, is accomplished, according to the Sutorbuilt Corp., 2008 East Slawson Ave., Los Angeles, Calif., by means of its new line of air unloaders. An accompanying view shows the construction of one of these machines which is said to be suitable for unloading such products as potash, borax ore, soda ash, phosphate rock and other materials.

60-ton portable air unloader



MANUFACTURERS' LATEST PUBLICATIONS

Apparatus. American Instrument Co., 774 Girard St., N.W., Washington, D. C.—Publications as follows: Bulletin 1220, Thermostatically controlled bath; 1203, Portable unit for bath temperature control; 1500, Immersion heaters; 1520, Miscellaneous laboratory heating apparatus.

Atmosphere Control. Hevi Duty Electric Co., Milwaukee, Wis.—Bulletin 1132—Describes a method of atmosphere control for electric furnaces.

Automatic Control. The Foxboro Co., Foxboro, Mass.—Bulletin 175—32 pages giving complete simplified explanation of principle and use of this company's system of "Stabilog" control.

Bearings. Joseph T. Ryerson & Son, Chicago, Ill.—Folder describing textile-reinforced synthetic-resin bearings.

Blowers. Roots-Connersville-Wilbraham, Connersville, Ind.—Publications as follows: 21-B15, Use of R-C-W blowers in ice production; 31-B-11, Type XA pumps for gases and vapors; 100-B11, Vacuum-blowing cleaner units.

Chemicals. The Grasselli Chemical Co., Cleveland, Ohio—Booklet describing the curing and hardening of concrete with silicate of soda; also folder briefly describing use of trisodium phosphate.

Chemicals. Halowax Corp., 247 Park Ave., New York City—Folder describing properties and uses of Halowax, a synthetic, wax-like substance.

Dust Protection. Pangborn Corp., Hagerstown, Md.—Bulletin 193—Folder describing a number of industrial helmets and other protective clothing made by this company.

Electrical Equipment. General Electric Co., Schenectady, N. Y. Publications as follows: Bulletin GEA-383D, Low-speed, alternating-current generators; GEA-957C, Mechanical-drive turbines, GEA-1145B, Mechanical-drive turbines; GEA-1191A, 54 pages on synchronous motors; GEA-1480B, Photoelectric recorders; GEA-1520A, 36 pages on electric heating units.

Equipment. Patterson Foundry & Machine Co., East Liverpool, Ohio—8 pages graphically illustrating this company's wide range of special process equipment.

Exhausters. Pacific Foundry Co., Ltd., 3100 Nineteenth St., San Francisco, Calif.—Bulletin 130—16 pages on the corrosion resistant alloy "Corrosiron," and on acid-resisting fans and exhausters, fume systems, hoods, pipe and fittings made of this material.

Fans. Buffalo Forge Co., Buffalo, N. Y.—Catalog 490C—16 pages describing this company's line of motor-driven fans and exhausters.

Flow Indication. Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.—Collection of new bulletins on vertical and inclined direct-reading manometers made by this company.

Flow Indication. Schutte & Koerting Co., Philadelphia, Pa.—Bulletin 6-F—8 pages on high and low pressure Rotameters for flow rate indication.

Flow Meters. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.—Bulletin 1058—Folder describing constructional details of this company's flow meters equipped with a new magnetic clutch.

Haveg. Haveg Corp., Newark, Del.—20 pages describing properties of the asbestos-filled, phenol-formaldehyde resinoid, Haveg, and the types of chemical equipment for which it is used. These range from small equipment to one-piece tanks as large as 10x10 ft. Also discusses Havegit, an acidproof cement for cementing Haveg or other materials.

Heat Exchangers. The Superheater Co., 60 East 42d St., New York City—Reprint of a paper presented before the A.S.M.E. on "Measurement of Metal Temperatures on Heat-Receiving Side of Heat-Exchanging Apparatus."

Illumination. New Jersey Zinc Sales Co., 160 Front St., New York City—12-page booklet entitled "Using Paint as Light," a simplified summary of a paper on the influence of the reflecting characteristics of wall paints upon artificial and natural illumination.

Lubrication. Acheson Oildag Co., Port Huron, Mich.—Bulletin 113.4—3 pages on the importance of colloidal-graphited lubricants in "running in" operations.

Lubrication. National Carbon Co., Carbon Sales Division, Cleveland, Ohio—Catalog Sections G132, 232 and 332—Publications of 8, 6 and 6 pages respectively, covering Gredag lubrication, lubrication of outdoor equipment, and lubrication of industrial equipment.

Metals and Alloys. Baldt Anchor, Chain & Forge Corp., Chester, Pa.—Chart listing physical properties of heat- and corrosion-resisting alloys.

Metals and Alloys. Electro Metallurgical Co., 30 East 42d St., New York City—20 pages illustrating and outlining the uses of stainless steels.

Metals and Alloys. Ingersoll Steel & Disc Co., 310 South Michigan Ave., Chicago, Ill.—Folder describing the use of stainless-clad steels made by this company's ingot process.

Metals and Alloys. International Nickel Co., 67 Wall St., New York City—Bulletins T4 and 5—Respectively 12 pages, on methods for fabrication of nickel-clad steel plate; and 8 pages, on the engineering properties of Monel metal.

Microscopy. E. Leitz, Inc., 60 East 10th St., New York City—Bulletins 2 and 3—Respectively 16 and 8 pages on darkfield microscopy for metal analysis; and this company's simplified micro-metallograph.

Minerals. Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.—20-page article on occurrence and uses of Witherite (natural barium carbonate).

Power Transmission. Morse Chain Co., Ithaca, N. Y.—Bulletin 51—56 pages on roller- and silent-chain drives, sprockets and flexible couplings. Lists prices and gives complete data.

Power Transmission. Reeves Pulley Co., Columbus, Ind.—Bulletin T-5645—17 pages on automatic, variable-speed control by the use of this company's variable-speed transmissions.

Pressure Control. American Meter Co., 105 West 40th St., New York City—Catalog RG-1—40 pages on regulators for high and low pressure gas and bottled gas.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: Bulletins W-101-SI-7 incl., Horizontal duplex steam piston pumps; Bulletins W-103-SI-6 incl., Pot-valve pumps for oils.

Rubber. B. F. Goodrich Rubber Co., Akron, Ohio—Publications as follows: Bulletin 251, Cutless rubber guide bearings for hydraulic turbines; 2105, Highflex transmission belts; 2260, Maxecon conveyor belting; 9010, Armorite abrasion-resisting rubber; 9580, Linerite rubber linings for rotary grinding mills.

Rubber. Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic, N. J.—Bulletin R—24 pages on protective rubber linings and covering.

Safety. Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York City—20 pages on methods of organizing and conducting industrial safety contests.

Screening. Orville Simpson Co., 1230 Knowlton St., Cincinnati, Ohio—Folder 6—Folder describing the principle of operation of this company's Rotex screeners.

Screens. Link-Belt Co., Philadelphia, Pa.—Catalog 1362—Description, data and installation views on unbalanced-pulley-drive, and heavy-duty positive-drive, screens.

Steam Transmission. Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.—Bulletin EJ-1904—16 pages on this company's cylinder-guided expansion joints, describing the features of its new method of gun-type packing.

Temperature Control. Sarco Co., 183 Madison Ave., New York City—Bulletin 52—12 pages covering types and applications of this company's temperature regulators.

Weights. Pfaltz & Bauer, Inc., 300 Pearl St., New York City—Leaflet describing the new Sartorius 1-2-3-5 arrangement of analytical weights now being offered by this company.

Welding. Air Reduction Sales Co., Lincoln Bldg., New York City—26 pages on the advantages, production and use of welded piping.

Weld Testing. Linde Air Products Co., 30 East 42d St., New York City—Bulletins describing this company's Type TM-3 extensometer and the Oxweld portable tensile testing machine.

NEWS OF THE INDUSTRY

Chemical Engineers schedule summer meeting prior to Engineering Week at Chicago Exposition. Du Pont brings three suits to protect Cellophane patents. Dyers and Finishers form institute. British Dyestuff Act to remain in force through 1933. Different bills before Congress propose measures to govern imports from countries where currencies are depreciated

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Plans for Engineering Week At Chicago Exposition

PLANS for the conference of engineers during Engineering Week, June 25-30, of the Chicago Century of Progress Exposition, are making excellent progress. Chemical engineers will participate in the activities of this week along with twenty other of the national engineering societies and associations. The American Association for the Advancement of Science meets in Chicago the week prior to Engineering Week. The American Institute of Chemical Engineers has scheduled its summer meeting here June 14-16.

On Sunday evening of June 25, when Engineering Week officially gets under way, the International Union of Pure and Applied Physics will have a joint session with section M of the American Association for the Advancement of Science. A number of the engineering societies will participate in this joint meeting with a program which is being arranged on the "Application of Physics to Engineering," by R. A. Millikan. On the evening of June 27, A. P. M. Fleming and H. Gough of England will address another similar joint session on "Industrial Developments of the Century."

In addition to the individual activities of all of the various groups during Engineering Week, there will be a joint assembly on Engineers Day. The program for this day includes a banquet at the Hotel Stevens. This banquet is expected to be the largest affair of its kind ever held by engineers, with an attendance of more than 3,000. The program which is not yet ready for announcement will include addresses by several internationally famous scientists and engineers.

In addition to the many interesting educational exhibits at the Century of Progress Exposition, chemical engineers will also see much of value at the Sixth Midwest Engineering and Power Exposition, to be held at the Coliseum during that week. At this exposition some 300 manufacturers will show the latest developments in steam generating equipment for power and process purposes. In addition there will be a wide range of equipment such as pumps, heating and air conditioning apparatus, water softeners, and welded pipe and fittings.

A. I. Ch. E. Adds Purdue to Accredited List

PURDUE UNIVERSITY has now been added to the list of educational institutions recognized by the American Institute of Chemical Engineers as "prepared to teach chemical engineering according to acceptable standards." This action was taken at the meeting of the Council of the Institute on Jan. 13, 1933, following the recommendation of the Committee on Chemical Engineering Education of which Dr. Harry A. Curtis is chairman. In the list published in the most recent volume of the *Transactions* (Vol. XXVII, 1931), the following institutions are named: Armour Institute of Technology; California Institute of Technology; Carnegie Institute of Technology; Case School of Applied Science; Columbia University; Iowa State College (Ames); Lehigh University; Massachusetts Institute of Technology; Ohio State University; Polytechnic Institute (Brooklyn); Rensselaer Polytechnic Institute; State University of Iowa (Iowa City); University of Cincinnati; University of Michigan; University of Minnesota; University of Pittsburgh; University of Washington (Seattle); University of Wisconsin, and Yale University.

Freeport Texas Finances New Sulphur Project

RECENT offering for public financing of a new issue of \$2,500,000 Freeport Texas Co. 6 per cent cumulative convertible preferred stock of \$100 par value was oversubscribed by approximately twice the amount of the offering. In the annual report of the company, President Norton stated that approximately \$3,000,000 would be spent in the development of the sulphur property recently acquired at Grand Ecaille, La. The sulphur rights on this property were leased from the Gulf Refining Co., Shell Petroleum Co. and Humble Oil & Refining Co. It is expected that production of sulphur will be started early in 1934.

In his remarks to stockholders President Norton said that the construction of the plant of the Cuban-American Manganese Corporation at Isabelite, Oriente Province, Cuba, has been completed and this company is now producing the highest grade of manganese concentrates that have been imported into this country.

Society of Chemical Industry Meeting

A meeting of the Society of Chemical Industry will be held on the evening of Feb. 24 at the Chemists' Club, New York. The speaker will be Sheppard T. Powell, consulting chemical engineer of Baltimore, Md., who will present a paper on "The Creation and Correction of Trade Waste Problems." Preceding the meeting a dinner will be held. Non-members interested in the subject of the paper are invited to attend.

Du Pont Sues to Protect Cellophane Trademark

THE Du Pont Cellophane Co., Inc., on Feb. 2 filed suit in the United States District Court for the Southern District of New York against S. H. Kress, Inc., chain store merchants, and also filed suit in the United States District Court for the Eastern District of New York against Waxed Products Co., Inc., wholesalers, of Brooklyn, N. Y., alleging that these concerns had sold as "Cellophane," products not made by the Du Pont Cellophane Co. The complaint states that since the introduction of cellulose film into the United States the Du Pont Cellophane Co. and its predecessors have had exclusive right to the word "Cellophane" as a trademark for this production. These suits have been instituted for the purpose of maintaining the exclusive right of the Du Pont Cellophane Co. in its trademark "Cellophane" and to prevent the use of such trademark upon similar material manufactured by its competitors.

Alleging infringement of moistureproof cellophane patents, the Du Pont Cellophane Co. has filed suit against the Sylvania Industrial Corp. in the U. S. District Court for the Eastern District of Virginia, at Richmond. The manufacturing plant of the defendant is located at Fredericksburg, Va.

The bill of complaint alleges infringement of patents covering moistureproof material, moistureproof composition, apparatus for coating and method of coating, which include letters patent 1,737,-187, 1,826,696, 1,826,697, 1,826,698, and 1,826,699, all of which relate to the manufacture of moistureproof cellophane.

British Dyestuffs Act to Remain Effective

FOR the third year in succession the Dyestuffs Import Regulation Act of 1920 has been included in the annual routine Expiring Laws Continuance Act, which was passed by Parliament just before the Christmas recess. The Dyestuffs Act will accordingly remain in force during 1933 on the same basis as in 1932. The Government's decision to continue the Act another year represents a compromise between the majority reports of the Dyestuffs Industry Development Committee, which recommended a continuation for three years, and the minority recommendation of the representatives of the Color Users' Association on the Committee, advising that the Act should be allowed to lapse at the end of 1932.

In its review of developments during 1932 the majority report of the Dyestuffs Industry Development Committee refers to the consolidation of the industry in recent years and states that the greater part of it is now under the control of Imperial Chemical Industries, Limited. It points out, however, that there are some 13 other firms whose contribution to the output is very valuable in the manufacture of special products which are not otherwise available from British sources. With regard to price fluctuations of British dyestuffs, the report says it is estimated that prices of individual dyestuffs, have been raised on the average by about 22½ per cent during 1932.

Dyers and Finishers Form Institute

ARTICLES of incorporation were filed in the latter part of last month for the Institute of Dyers and Finishers. The incorporators included practically all the dyeing and printing companies in the vicinity of Paterson, N. J.

Any corporation, firm or individual engaged in the dyeing, printing, processing or finishing of textile fabrics in the United States is eligible to membership in the institute, according to its articles of incorporation.

The object of the institute is to consider and act upon problems of the dyeing industry, dealing with tariff, traffic, transportation, legislation, insurance, welfare of employees, labor disputes, credits, financial responsibility of customers, cost accounting, trade practices, statistical reports and design piracy, with the view of maintaining and improving high standards of quality and service in the business.

Officers are Charles L. Auger, National Silk Dyeing Co., president; Herman Geller, International Dye & Print Works, vice-president; Robert Salembier, secretary-treasurer.

Solvents Used in Canadian Paint Trade

A decline in the consumption of a number of solvents used in the Canadian paints, pigments and varnishes industry in 1931 as compared with 1930 is indicated in a report recently released by the Dominion Bureau of Statistics. The following table shows the solvents used in 1930 and 1931:

	1930	1931
Turpentine (gum spirits), gal	486,435	440,834
Wood turpentine, gal	51,125	36,517
Petroleum distillate, gal	2,390,502	1,913,141
Acetone, lb	216,160	76,854
Acetic acid, lb	285,127	221,750
Amyl alcohol, gal	22,278	27,056
Amyl acetate, gal	1,352	12,535
Butyl alcohol, gal	40,219	23,906
Butyl acetate, gal	127,929	105,997
Ethyl alcohol, gal	98,875	62,772
Ethyl acetate, gal	136,700	117,860
Methanol, gal	136,077	123,435
Creosote, gal	76,102	65,259
Coal tar naphtha and benzol, gal	423,330	311,319

Haskell Elected President Of Alcohol Institute

AT THE recent annual meeting of the Industrial Alcohol Institute, Inc., Glenn Haskell was elected president. The acceptance of the presidency by Mr. Haskell marks the climax of thirty-three years of experience in the alcohol industry. He is first vice-president of the U. S. Industrial Alcohol Co., and director of ten other companies associated with the alcohol industry. Mr. Haskell was elected a director of the Alcohol Institute in 1931.

Succeeding as president S. S. Neuman, who held office for two terms, Mr. Haskell will be supported by A. K. Hamilton of the Pennsylvania Sugar Co. and Mr. Grimm of the American Commercial Alcohol Corp. as vice-president and treasurer respectively. Dr. Lewis H. Marks was re-elected executive secretary, the position he has occupied since 1926.

The membership of the Industrial Alcohol Institute consists of eight of the large manufacturers of industrial alcohol whose total production amounts to 98 per cent of all industrial alcohol consumed by the industries and professions of this country. The Institute cooperates very closely with all Federal and State bureaus, responsible for the control and distribution of denatured alcohol and also in research to provide effective denaturants.

Research Laboratories List Under Revision

THE Research Information Service of the National Research Council is preparing a revision of its "Industrial Research Laboratories of the United States, including Consulting Research Laboratories," the fourth edition of which was published in 1931 and contained over 1,600 such laboratories.

This bulletin is the only list of industrial research laboratories known to the compilers and is used by many persons, not only as a source of information concerning such laboratories but also as a mailing list for important announcements concerning new apparatus and processes and for compilations of interest to research workers in industrial fields.

In addition to the 1,600 laboratories already known, it is very desirable that additional laboratories be listed, if such are in existence.

The data included in the bulletin are made up of the name and address of the firms, the research directors and the research problems engaging the attention of the laboratories. There are also included an alphabetical list of research directors, a subject index of research interests and an index of firms.

NEWS FROM WASHINGTON

By PAUL WOOTON
Washington Correspondent of Chem. & Met.

WASHINGTON wouldn't be Washington if, as March 4 approaches, it did not speculate on the fate of personalities as well as policies of government. Observers for the chemical industry are wondering, for instance, whether there will be a controversy over the appointment of a Commissioner of Industrial Alcohol to serve the next administration. James M. Doran, the present office holder, has served to the satisfaction of both the ardent regulationists and the industrial alcohol producers. This group, represented principally by their advisory committee, are working to have Doran retained. But others, particularly critics of his policy regarding such denaturants as methanol, apparently would welcome a change.

This job is a luscious political plum, normally carrying a salary of $9,000. Presumably it will be handed to the man of Jim Farley's choice. The supposed intimacy of the chairman of the Democratic National Committee with certain big methanol producers may, it is augured, prove a deciding factor in the ultimate decision. This becomes fairly credible when it is remembered that one of the most criticized decisions by Commissioner Doran was that forbidding the use of methanol as a denaturant on the ground that it legalized murder with poison liquor.

Philippine independence is, at bottom, the direct outcome of the fight of sugar, butter and industrial fat producers against duty-free imports. But the oil and fat producers were so busy nailing up the front door that they left the back door wide open. The bill as finally enacted over President Hoover's emphatic veto provides that trade between the Islands and the United States shall not, save in three commodities, be restricted by any new barriers during the decade of preparatory development for complete autonomy. Thus the United States virtually guarantees not to put any present non-dutiable goods under tariff restriction and not to raise present tariffs any higher.

The excepted commodities were sugar, coconut oil and cordage. But the law is silent as to copra, the raw material from which coconut oil is made, and copra is now on the free list. The representatives of industrial fat consumers were well aware that this source of supply would be protected by importing, not coconut oil but copra and recovering the oil in this country.

Tariff Legislation Deferred

It is impossible to predict what the next Congress will do but so far as the present Congress is concerned, repairing the tariff wall against off-gold countries isn't in the cards. The demand for such legislation is real enough and there was a chance until the administration threw its weight against it. Republicans in league with insurgent democrats could have carried such a bill through the House and possibly the Senate.

But this was before Secretary of the Treasury Mills and Chairman O'Brien, of the Tariff Commission, let loose a broadside. Whether or not the advantages to other nations of depreciated currency are illusory, as Chairman O'Brien contends, Republican regulars have restrained their enthusiasm to do something about it.

Even if the bill that will be forced to a vote in the House Feb. 13 should pass, it will die in the Senate. Without Republican support, high-tariff Democrats also are likely to be more docile. Democratic leaders opposed the legislation from the start but found it expedient not to attempt to enforce their will. Now their argument will be that President Roosevelt should have a free hand in his tariff-bargaining policy.

The theory of reciprocity originated with the Republicans but it doesn't promise to work any better in the hands of the Democrats. Democrats who know their tariff admit this privately. Assuming that such obstacles as most-favored-nation treaties can be swept aside or circumvented, it still remains to find one industry in the U. S. A. that would be willing to sacrifice a little in order that another might gain much. Reciprocal tariffs are logical but they are not practical politics. President Roosevelt will rule with a high hand, indeed, if he can persuade the Senate to ratify such agreements without nullifying reservations.

After eight years of litigation, the question whether the Tariff Commission can be compelled to disclose information relative to the costs of production of a particular company involved in flexible tariff proceedings has finally been disposed of by the U. S. Supreme Court. In the case at bar the Norwegian Nitrogen Products Company sought to obtain from the Commission cost data submitted by the American Nitrogen Products Company to support its application for an increase in duty on sodium nitrite. The importing company contended that the refusal of the Commission to disclose this information abrogated its right to a "hearing." In writing the opinion of the court, Justice Cardozo held that "within the meaning of this act, the 'hearing' assured to one affected by a change of duty does not include a privilege to ransack the records of the Commission, and to subject its confidential agents to an examination as to all they have learned."

Code for Water Transportation

With safety in rail transportation of explosives, commercial acids and other dangerous articles guarded by a code developed over a period of 25 years, the Interstate Commerce Commission has turned its attention to promoting safety in transportation by water. For this purpose the Commission was vested with broad authority by Congress in 1921, but rail regulations had to be revised before it could tackle the problem of water transportation intelligently. This, in itself, was a formidable task.

Because so much freight is interchanged between railroad cars and vessels, the Commission's bureau of service, in its tentative regulations governing water transportation, has proposed substantially the same requirements for packing, marking and billing. To what extent these will be acceptable to shippers and carriers the Commission is just now learning.

Shippers engaged in export trade are confronted with the demands of their foreign customers and, within limits, must comply in order to meet the competition of suppliers in other countries. In import trade there is no answer yet to the question whether the "dangerous article" must arrive at port in containers specified for use in this country. It may be covered by simply requiring, as the Commission does now in railway transportation, that foreign shippers shall be informed of packing requirements. That does not, however, cover stowage on ships.

The law behind the Commission relates only to safety in transportation of the commodity, not to the type of ship to be used nor to navigation, but there are many complications in drafting regulations adapted to all the types of vessels and conditions encountered on inland waterways and in coastal and foreign trade.

All interests will be heard before the code is finally prescribed as the Bureau of Service realizes that otherwise handicaps may be imposed that amount to exclusion of the traffic. In the meantime the control exercised by the Underwriters Association and the U. S. Steamboat Inspection Service remains operative. The goal of the I. C. C. is to develop practices in packing, handling and stowage that will eliminate disasters to vessels both in harbor and at sea.

FROM ABROAD

By Special Correspondents of Chem. & Met. at Berlin and Paris

Paris

CIRCUMSTANCES are favorable for international agreements in so much as the different producers are succeeding in organizing and especially in limiting the output in the various countries in proportion to the present actual consumption, as well as demarcating the markets and in certain cases the price. It is undeniable that one of the most deeply-rooted causes of the present economic crisis has been the over-production of numerous industrial and metallurgical products so that one can only view these agreements favorably.

Since the international accord among producers of viscose can be announced as an accomplished fact, the French producers have definitely entered the international group called together by the German viscose producers which results in the realization of the accord which had been foreseen six months ago between the French producers of artificial silk on one side and the Belgian producers on the other side. This pact is valid from Jan. 1, 1933, and in order to guarantee a continuation, it has been constituted The Alliance of Exporting Producers of Artificial Silk (A.E.P.A.S.) under the management of a company with variable capital and concerned mainly with supervising the French sales of viscose of Germany, fixed at present at about 6 per cent of the German consumption.

Let us remember, at this moment, in order to show the importance of this industry in France, that the production in 1930 amounted to 23,000 tons, representing a value of approximately 900,000,000 francs, an increase of 200,000,000 over 1928. If the volume of present production is not much lower than that of 1930, it is necessary by contrast to note the considerable reduction in prices. This reduction was about 20 per cent in 1931 and it has continued in 1932, so that present French prices are now on a level with international figures. This equalizing was all the more necessary since 30 per cent of French production is exported, while the importation barely reached 5 per cent.

In a general way the factories are rather busy, and the old concerns, in spite of the bare margin between cost and selling price, are working at a profit, although the latter is decidedly reduced. It is not the case with the factories established in latter years, which are experiencing financial difficulties: for example, the Chemical Textiles of the North and East which belong to the Kuhlmann group, having declared a loss of more than 17,000,000 francs, have had to reduce their capital to 20,000,000. It is to be expected that other firms will be also forced to practice economy.

There has at present been a great deal of talk about a new accumulator for iodine described by Francois Boissier which it is claimed constitutes the greatest progress achieved in this domain since Edison's invention of the alkaline accumulator of ferro-nickel. This new accumulator is made in the form of a dry cell, with a cylindrical shape, which includes in the center as a positive electrode, a cylinder of graphitic carbon, surrounded by a sheath of absorbent coal dust or very dry special porous fuel—a jacket connecting with the carbon and the fuel serves at the same time as a porous diaphragm and as an absorbent for the electrolyte. The whole thing is enclosed in a cylindrical receiver of zinc forming the negative electrode. The electrolyte is used in the form of a solution of iodide of zinc at 60 deg. Bé, approximately, which is rendered immovable and yields no gaseous emission. During the charge, the zinc iodide is decomposed; the zinc is deposited on the negative electrode and the iodine on the positive, while the remainder is absorbed by the coal dust or fuel. The specific capacity is probably 60 amp.-hr. per kilo total; the electromotive force reaches 1.2 volts and the efficiency would be from 70 to 80 per cent.

Already an organization with a capital of 1,000,000 francs has been established for the commercial exploitation of this invention and is engaged in increasing its capital to 10,000,000 francs.

Rare Gas in Illumination

Georges Claude has succeeded in perfecting, with his cousin, Andre Claude, illumination with the aid of rare gases or metallic vapors. A light comparable to that of day has been obtained by means of neon-mercury tubes with a current of less than 10 volts. Thus in a room 200 meters square with an illumination of 400 lux, they have been able to effect 28 per cent economy of electrical energy, compared with that which would be necessary to obtain the same lighting effect with 1-2 watt lamps.

Berlin

DURING THE last months of 1932 German coal production showed an increase over the preceding months, indicating that the decline in industrial activities had at least been checked. The well-known soap manufacturers Henkel & Co., in Düsseldorf, has acquired an interest in Deutsche Hydrierwerke A. G., Rodleben; the explanation of this move is probably to be found in the marked success which Deutsche Hydrierwerke has attained in the manufacture and refining of fatty acids, and in the production of solvents, a field in which Henkel & Co. is much interested.

The contemplated increase in tariff on lubricating oils and gas oil is meeting opposition from the National Association of the Petroleum Industry. Present German consumption of lubricating oils is about 270,000 metric tons annually, of which 78 per cent is imported. One-fifth of the total is used in the transportation field; part of the saving gained in this field through recent reduction in gasoline prices would be lost if the increase in tariff should take effect. An increase in the price of gas oil would also affect tens of thousands of industrial establishments and agricultural plants where diesel engines are used; agriculture alone consumes about two-thirds of the petroleum imported for motor fuel.

According to a statement by Burbach-Kaliwerke A. G. the Volkenroda production of crude oil has dropped from 170 tons per day in 1931 to 30 tons at the present time. The economy of the operation is, however, satisfactory in spite of the reduced output, as the major part of the operating expense is charged against the potash production.

Insulating oils may now be produced from naphthene and iso-paraffin base oils which have been freed from aromatic and unsaturated hydrocarbons by intense refining, according to an Austrian patent by Siemens-Schuckert. Such oils are almost inert toward atmospheric oxygen and do not give any sediment.

Production of water gas in coke ovens has, according to a report by G. Lorenzen (coal department) given coke manufacturers a good method for meeting greater demands for gas without increase in the amount of coal used. In an arrangement used by the firm Dr. C. Otto & Co., for instance, steam is introduced by nozzles through the charge-hole covers, away from the risers. This method also makes it possible to take care of peak loads by production of carbureted water gas, as atomized coal tar or similar products may be blown into the coke oven with the steam.

The Association for Coal Technique, Dortmund-Ewing, is undertaking re-

search on utilization of coal and coal products; work of similar nature is also carried out by the Kaiser Wilhelm Institute for Coal Research. The following excerpts from a report by Prof. Gluud indicate the results achieved in the production and recovery of ammonia, sulphur, cyanide, and hydrogen. A number of processes are in operation to utilize the ammonium chloride produced in the Solvay process as fertilizer, or to convert coke-oven ammonia into fertilizer. In addition to synthetic ammonia one of these processes manufactures sodium carbonate and caustic soda. In connection with this process a method has been developed for production of ammonium bicarbonate, the efficacy of which as a fertilizer has been proved by extensive tests at numerous agricultural experimental stations. A simple method of producing the carbon dioxide required in the production of the bicarbonate is based on the method of making hydrogen by cracking coke-oven gas (German patent No. 528,240). The wet method for removing sulphur from gas by the use of a suspension of iron hydroxide has been tested with excellent success on a daily gas output of 100,000 cu.m. at the Mont Cenis plant and elsewhere. A wider field opened by the technical results obtained at Dortmund-Ewing is offered by a process for the manufacture of hydrogen from coke-oven gas, in which the hydrocarbons are treated with steam and air at high temperature, whereby carbon monoxide, carbon dioxide, and hydrogen are produced. Production of alcohol from the ethylene in coke-oven gas by the use of a catalyst has given satisfactory results; commercial exploitation of this process is, however, prevented by regulations by the alcohol monopoly.

Oxygal is the name of a powder put on the market by "Griesogen" G.m.b.H. (I. G. Farbenindustrie), for production of oxygen by chemical means. The powder when packed in air-tight steel drums is said to keep almost indefinitely. When used it is placed in a retort and ignited, upon which the evolution of oxygen starts; 1 kg. powder gives 300 liters of oxygen. Griesogen has constructed a portable oxygen generator, in which the gas is evolved at 15 atm. pressure which may be reduced to the desired pressure by a reducing valve.

A new heat-resistant material for hydrochloric acid absorbers, the Dioxsil absorber, is being produced by Jena Glaswerk Schott u. Genossen. The ceramic materials usually employed for this highly exothermic process have generally not sufficient heat resisting qualities. The construction of the new absorber permits a higher efficiency than the tourille commonly used for this work. By placing the apparatus in a cooling trough a better efficiency is obtained; at the outlet of the second absorber the temperature is 30-50 deg. C.

Sinterkorund is the name of a new product produced by Siemens, by sintering chemical pure alumina at a very high temperature.

Commercial Possibilities Of Muscle Shoals

As a RESULT of an expenditure of over a million dollars for engineering and economic surveys, President-Elect Franklin D. Roosevelt, in selecting the Tennessee river basin for intensive development, has chosen one of the few large areas in the country on which the necessary basic studies have been completed. The work was done by the Corps of Engineers, U. S. Army. It required nearly eight years for completion. The cost of carrying out the entire project is estimated at $1,200,000,000.

Congress was influenced to appropriate large amounts for this study because of the unusual resources of the region which contains more than 40,000 square miles. The area has great agricultural possibilities and contains important mineral deposits.

Full development would provide relatively cheap power for distribution over distances up to 350 miles and for large chemical and other manufacturing operations near the dam.

In addition to the large amount of cheap power that would be available the improvement of the river would provide a cheap form of transportation through the great industrial region it is planned to build up. The navigation project calls for a depth of nine feet from the mouth of the Tennessee to Knoxville and for a depth of from 6 to 9 feet for a considerable distance up the major tributaries.

A thorough-going commercial report was made by the Army engineers. This shows that reserves of coal in the basin amount to 1,835,000,000 tons. Reserves of phosphate rock are placed at 92,400,000 tons. Iron ore that can be regarded as available for use is reported to be 169,047,000 tons. Sand and gravel and limestone exist in inexhaustible quantities. Zinc ore reserves are calculated as being 45,000,000 tons. Bauxite reserves were found to be 700,000 tons. There are large reserves of marble. Asphalt rock reserves amount to 17,000,000 tons. Reserves of copper ore in the Ducktown district are known to exceed 8,000,000 tons. Reserves that cannot be regarded as available at present are many times that amount. Barite, clay and slate are available in unknown amounts. Manganese is another mineral occurring in the area.

Building up of an electro-chemical industry at Muscle Shoals would be one of the features of any comprehensive scheme of development. This would include such activities as the separation of aluminum from its ore and the production of caustic soda. With phosphate rock reserves nearby it probably will become a center of production of phosphoric acid. Much doubt is expressed that Muscle Shoals would become a great center for the production of fixed nitrogen. Since the time of the erection of the nitrogen plant at Muscle Shoals the art of fixing nitrogen has made great progress. It is regarded as improbable that use could be made of that plant under present conditions. Moreover, specialists from the government's fixed nitrogen laboratory have taken the position that Muscle Shoals is not so located with respect to raw materials and consuming markets to be a logical center for nitrogen production. Even if nitrogen is not considered there is very general agreement that all of the power that can be produced at Muscle Shoals eventually would find a market for public utility use within a radius of 350 miles and for the production of chemicals which require cheap power. Friends of the development envisage Muscle Shoals surrounded by much the same type of industrial development as has taken place in the Niagara Falls region.

CALENDAR

American Institute of Chemical Engineers, spring meeting, Chicago, Ill., June 14-16.

American Chemical Society, 85th meeting, Washington, D. C., March 26-April 1.

Electrochemical Society, spring meeting, Montreal, May 11-13.

American Society for Testing Materials, Chicago, Ill., June 26-30, 1933.

Fourteenth Exposition of Chemical Industries, New York, week of Dec. 4-9, 1933.

American Pertoleum Institute, Tulsa, Okla., May 17-19, 1933.

Correction: On page 33 of our January, 1933, issue it was stated incorrectly, through an error in transcription, that General Chemical Co. had, during 1932, sued Monsanto Chemical Works with regard to a vanadium catalyst patent. The defendant was actually the Selden Co. as was evident from the reference given. Monsanto has never been sued over its vanadium catalyst.

NAMES IN THE NEWS

A. E. MARSHALL, consulting chemical engineer, left New York City Jan. 31 for a several weeks trip. While in Cuba, Louisiana and Texas he plans to look over the heavy chemical industry, and in the latter two states the natural gas industry.

JOHN J. ABEL, emeritus professor of pharmacology of the Johns Hopkins Medical School, was awarded the first Conné medal on Dec. 28. This medal is awarded by the Chemists' Club of New York City to "an individual responsible for a discovery in chemistry which has proven of value in treatment of human disease."

A. D. CAMP, director of research and development for the Ideal Roller & Manufacturing Co., has transferred the scene of his activities from Chicago to Springfield, Ohio, where he expects to remain for several months.

CHARLES L. REESE, member of the board of directors of the E. I. du Pont de Nemours & Co., Inc., has been elected president of the American Chemical Society for 1934. He will succeed Prof. Arthur B. Lamb who is president this year.

GEORGE OLIVER CURME, JR., vice-president and director of research of the Carbide & Carbon Chemicals Corp., has been awarded the Chandler medal for 1933. When announcing the medalist Prof. Arthur W. Hixon, of the Department of Chemical Engineering, Columbia University and chairman of the award committee, stated that Dr. Curme has worked out practical methods for the production of ethylene glycol, ethylene dichloride, ethylene chlor-hydrine, ethylene oxide, diethyl sulphate, dichlor ethyl ether, and many other organic compounds.

W. McLEAN BINGLEY has been appointed assistant sanitary engineer of the Chlorine Institute, Inc., New York City. Bingley is a graduate of Johns Hopkins University and was formerly in the employ of the Dorr Co.

HANS MOLITOR, of the University of Vienna, has been appointed director of research in pharmacology for Merck & Co. Dr. Molitor's first duties will be to supervise the construction of a laboratory building at the company's plant at Rahway, N. J., and the selection of a suitable research staff.

ROBERT E. WILSON

ROBERT E. WILSON, member of the board of directors, Standard Oil Co. of Indiana, has been advanced to the newly created position of vice-president in charge of research. Dr. Wilson resigned directorship of the research laboratory of applied chemistry, Massachusetts Institute of Technology, to accept a position on the research staff of the oil company in 1922.

R. E. HUMPHREYS, vice-president in charge of manufacturing companies, Standard Oil Co. of Indiana, retired Jan. 1, 1933. Dr. Humphreys has been in the employment of this company for 32 years, having entered its service directly after graduating from Johns Hopkins University. He was very closely associated with the development of the Burton process whose far-reaching consequences have markedly influenced subsequent developments in the petroleum industry.

MAX G. PAULUS, formerly general manager of manufacturing of the Standard Oil Co. of Indiana, has succeeded to Dr. Humphreys' position as vice-president in charge of manufacturing. Dr. Paulus is an alumnus of Johns Hopkins University. He entered the service of the oil company as a member of the research staff at the Whiting refinery in 1915.

J. MITCHELL FAIN, formerly chemical engineer with the Flintkote Co., is now associated with Foster D. Snell, Inc., Brooklyn, N. Y.

R. S. HATCH, for the past five years in charge of technical development of the Pulp Bleaching Corp., has been appointed by the directors of the Weyerhaeuser Timber Co. to establish a research department at the company's plant at Long View, Wash.

WILLIS F. WASHBURN, general superintendent of the Titanium Pigment Company's plant at St. Louis, has been transferred to the company's main office in New York City.

PAUL E. PETERS of the Division of Chemical Engineering, University of Illinois, has accepted a position with the North Shore Coke & Chemical Co., Waukegan, Ill.

A. B. NIXON, general manager of the cellulose products department, and P. B. Stull, general manager of the Virginia cellulose department, of the Hercules Powder Co., were elected to the board of directors of the company. Nixon was formerly in charge of the company's nitrocellulose plant at Gillespie, N. J., and Stull was formerly president of the Virginia Cellulose Co. of Hopewell, Va., which was acquired by the Hercules company in 1926. The creation of the two new members allows for the complete representation of each major department of the company on the board.

M. J. WALSH, for the past seven years in charge of the operations of Thornley & Co. and its successor, the Kelco Co., at San Diego, Calif., has recently established his own factory for the production of dried kelp. His address is, Kelp Laboratories, 3694 Pershing Avenue, San Diego, Calif. Walsh has leased the kelp beds off the San Diego County coast, from the state of California.

PAUL C. RICH, who has been actively engaged in surveys on natural sodium sulphate deposits, has accepted a position as chemical engineer with the Rhodes Alkali & Chemical Corp. This company is at present producing and shipping salt cake from the natural deposits near Mina, Nev. The plant has been enlarged and production increased recently. Rich's address is Balboa Building, San Francisco, Calif.

FORREST D. PILGRIM is employed by the Tennessee Eastman Co. of Kingsport, Tenn.

WILBER D. BANCROFT, professor of physical chemistry at Cornell University, will be awarded the William H. Nichols Medal, Mar. 10, 1933. The medal will be presented by the New York Section of the American Chemical Society for Dr. Bancroft's work on the application of colloid chemistry to physiological problems, particularly insanity, in which he has advanced scientific proof that dementia and drug addiction are curable chemically.

OBITUARY

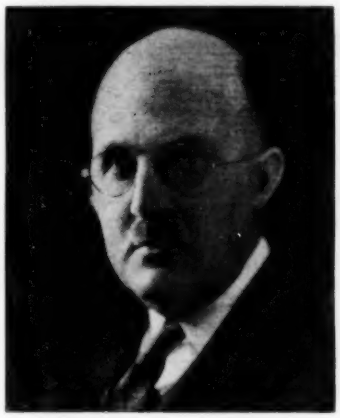
Guy Hodgens Buchanan died after an operation in New York City, Jan. 21, 1933. At the time of his death he was chemical engineer and chief technologist of the American Cyanamid Co. Mr. Buchanan attended both Washington and Jefferson College and the Massachusetts Institute of Technology, graduating from the latter institution in 1913. He was associated for a short time with the New England Coal and Coke Co. of Everett, Mass., and later with the research staff of the New Jersey Zinc Co. at Palmerton, Pa., where he remained until 1916, when he returned to the Massachusetts Institute of Technology as assistant professor of chemical engineering.

In 1917, Mr. Buchanan entered the services of the Cyanamid company working first at the Warners, N. J., plant. Later he was transferred to the staff of Air Nitrates Corp. and moved to Muscle Shoals, Ala., were he put into operation the ammonia oxidation and the ammonia nitrate units of United States Nitrate Plant No. 2.

Harold A. Clark, 39, assistant general sales manager of the McGraw-Hill Publishing Co, Inc., and formerly a member of the business staff of *Chem & Met.*, was killed in an automobile accident on Jan. 27. He was returning alone from a business conference in Wilmington, Del., when the car he was driving crashed into the trailer of a truck near Woodbridge, N. J. Mr. Clark, widely and popularly known as "Jeff" was captain and fullback of the famous Pennsylvania State football team of 1916. He was also captain of tennis, president of the class of 1917 and after graduation served for a number of years on the athletic advisory council of Pennsylvania State College.

After completing his course in chemical engineering, Mr. Clark was first employed by the Hercules Powder Co., in the production of explosives at Kenvil, N. J., Nitro, W. Va., and at other munition plants. He continued this connection after the war and developed a new type of pyroxylin plastic which was patented by the Hercules company. Mr. Clark entered the publishing business in 1921 and served first on the advertising staff of *Chem & Met.*, later representing *Engineering and Mining Journal* and *Coal Age* in New York and New England. In 1928 he was promoted to the sales executive staff where he directed important studies of the industrial market for paints, lubricants, and other products and equipment.

Walter King, superintendent of enameling at the Elyria plant of the Pfaudler Co. died Dec. 8, 1932, after a brief attack of pneumonia. He was 37 years of age at the time of his death. His association with Pfaudler dates back to 1917 when he began his career as a laboratory assistant. With the exception of a year and a half during the World War, when he saw action overseas, he had served the company continuously. In 1925, he was made superintendent of enameling and in this capacity introduced enameling practices which contributed to the expansion of enamel-lined equipment in many process fields.



GUY HODGENS BUCHANAN

HAROLD A. CLARK

Robert Howard Hawley was killed when he was hit by an automobile while crossing the street near his home at Los Angeles, Calif., Dec. 6, 1932.

Samuel Anthony Goldschmidt, chairman of the board of the Parsons Ammonia Co., and founder of the fellowship that bears his name at Columbia University, died Jan. 28, 1933, at his home in New York City of a stroke of apoplexy. He was 84 years old.

Dr. Goldschmidt was educated at the College of the City of New York and Columbia University. For several years he was engaged in research with Dr. Chandler of the Columbia faculty. In 1880, Dr. Goldschmidt became treasurer of the Columbia Chemical Works, later the Parsons Ammonia Co. of which he was president from 1894 to 1915, then chairman of the board.

Wilson Bradley died on Dec. 9, 1932, after a brief illness at his home in Deerwood, Minn. Mr. Bradley was the inventor and promoter of the Bradley-Laury process for leaching manganiferous iron ores.

Fred B. Lincoln, Sr., vice-president of Corhart Refractories Co. died of pneumonia and peritonitis following an operation for appendicitis at Louisville, Ky., Dec. 4, 1932. He was 65 years of age. Mr. Lincoln had followed engineering through his life. Prior to going to Louisville, when the plant was established six years ago, he was with the Erie railroad as general manager. He was a native of Brooklyn, N. Y., and spent most of his life there.

Thomas F. Burgess, who retired a year ago as vice-president and general manager of the National Sulphur Co. died on Dec. 27, 1932 at his home in Scarsdale, N. Y., of a cerebral hemorrhage. He was 69 years old. Before joining the sulphur company, Mr. Burgess had been vice-president of the Dean Linseed Oil Co., and secretary of the General Chemical Co.

William F. Edwards, director of research for the United States Testing Co. died at his home in Englewood, N. J., Jan. 12, 1933. He was in his seventy-seventh year. Dr. Edwards graduated from the University of Michigan in 1890, and from 1890 to 1895 was instructor of physics and chemistry at his alma mater. In 1895 he joined the faculty of the University of Washington and in 1897 became president serving in that capacity until 1900.

During the World War he was director of research for a combined laboratory of four of the leading automobile manufacturers and played an important part in the development of high strength alloy steels.

Edward H. Kellogg, general sales manager of the Mine Safety Appliance Co. of Pittsburgh, Pa., died Jan. 9, 1933, at his home at Squirrel Hill. He was buried in Arlington Cemetery, Washington, D. C., with military honors. Mr. Kellogg, was 40 years of age. He graduated from Kansas State College in 1911 where he specialized in chemistry. After serving in the Department of Agriculture, he joined the Chemical Warfare Service and went overseas. In 1919 he joined the research laboratory of the Brown Co. and two years later was with the Bureau of Standards investigating the possibility of using flax as a raw material for paper making.

CHEMICAL ECONOMICS

Production of chemicals in January was slightly lower than in December but with adjustments, based on number of working days, the rate of operations appears to have been higher than in the preceding month

IN MANY cases, production of chemicals in January was maintained at the same rate as in the preceding month and different producers reported that no change had been made in their operating schedules. Based on consumption of electrical energy the index number for chemical production was 118.7 for January which compares with 119.1 for December. From the figures available it is probable that the rate of operations was speeded up somewhat in January as inventory shut-downs reduced the number of actual working days for some plants. The electrochemical branch of the industry operated in a more active way with reports that heavy acid output was being held down. Alkali plants failed to hold a universal course as enlarged operations in some plants were offset by declines in other plant operations.

While sentiment regarding the outlook for general business has not been overoptimistic, it is clouded by the political situation. So far as the chemical industry is concerned, seasonal influences should work in favor of some expansion. Heavy industries, such as steel and building, give promise of some improvement. The output of automobiles in December was 107,403 units and the rate of production in January was on a rising scale although labor troubles held down the output a little. Consumption of silk increased in January over the preceding month and rayon producers not only are working full speed but have output sold ahead for about two months.

Many new products which offer outlets for chemicals are expected to reach commercial importance this year and while they may not greatly affect the volume of chemicals produced, nevertheless the development of new chemicals or of new uses for chemicals cannot be disregarded.

Referring to the changing status of foreign trade the Department of Commerce reports that the year 1932 so far as the foreign chemical trade was concerned showed several striking changes outside of the marked decline in the total, one of the most important of which was the increased exportation of synthetic sodium nitrate. Formerly, Chilean sodium nitrate was one of the leading import items, having accounted for four per cent of the total chemical imports in 1899, 15 per cent in 1927, and only two per cent in 1932.

In 1899 practically all the American consumption of coal-tar dyes was supplied by importation, which represented nine per cent of total chemical imports. By 1927 the United States had become an important supplier in world dye-consuming markets, although imports and exports each accounted for three per cent of their respective totals. Inasmuch as the dye trade in 1932 held up better than that of some other commodities, imports were responsible for six and exports for four per cent of the total chemical foreign trade.

For the third successive year, imports of chemicals and allied products were less than exports. Figures in 1932 were $72,000,000 for imports and $95,000,000 for exports.

Production of Dyes and Coal-Tar Chemicals in 1931 Reported by U. S. Tariff Commission

Table 1 — Coal-tar crudes: Production and sales, 1931

(In thousands)

	Sales	Production
Benzene (except motor benzol), gal.	14,267	14,772
Motor benzol, gal.	61,471	61,960
Toluene, all grades, gal.	12,693	11,833
Solvent naphtha, crude and refined, gal.	3,464	3,772
Xylene, gal.	2,074	2,029
Naphthalene (crude), lb.	19,554	20,934
Dead or creosote oil, gal.	96,327	105,917

Table 2 — Intermediates: Production and sales, 1931

(In thousands)

	Sales, Lb.	Production, Lb.
Total intermediates	124,186	267,213
Cresylic acid, refined (yielding below 215° C. tar acids equal to more than 75 per cent of the original distillate)	10,305	10,994
Naphthalene, solidifying 79° C. or above (refined, flake)	21,260	34,959
Phenol	14,002	17,981
Rubber chemicals	11,415	15,766
All other intermediates	67,204	187,512

Table 3 — Dyes and other finished coal-tar products: Domestic production and sales, 1931

(In thousands)

	Sales, Lb.	Production, Lb.
Dyes	85,220	83,526
Medicinals	6,240	8,567
Flavors and perfume materials	3,037	3,034
Vanillin	308	307
Synthetic resins	29,343	34,179
Photographic chemicals	732	695
Other finished products	2,555	3,047

Table 4 — Coal-tar dyes: Production and sales by classes of application, 1931

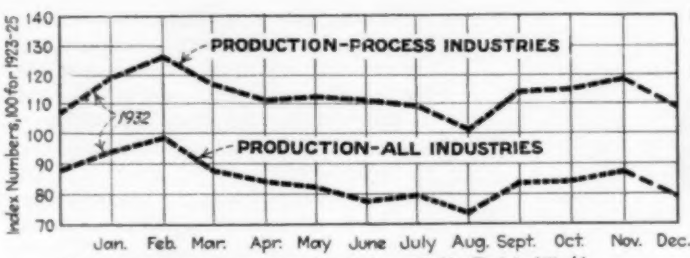
(In thousands)

	Sales, Lb.	Production, Lb.
Acid	11,373	11,471
Food dyes	303	293
Basic	3,779	3,701
Direct	19,551	19,414
Direct blacks	7,603	7,088
Developed colors	2,228	2,313
Other direct colors	9,721	10,013
Lake and spirit soluble	3,928	3,398
Mordant and chrome	4,317	4,329
Sulphur	15,179	15,940
Sulphur black	12,101	12,942
Vats (including indigo)	26,772	24,907
Indigo	18,003	16,330
Other indigoids	3,923	4,071
Other vats	4,846	4,505
Unclassified	320	366
Total	85,220	83,526

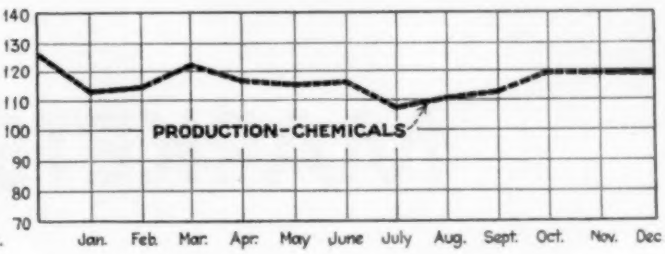
Table 5 — Synthetic coal-tar resins, production and sales, 1931

(In thousands)

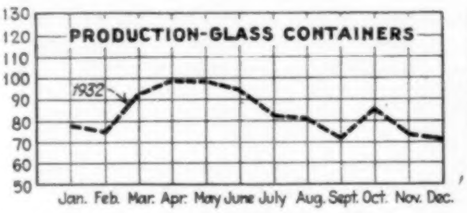
	Sales, Lb.	Production, Lb.
Derived from phenol and cresol	21,496	22,647
Derived from other sources	7,848	11,532
Total synthetic coal-tar resins	29,344	34,179

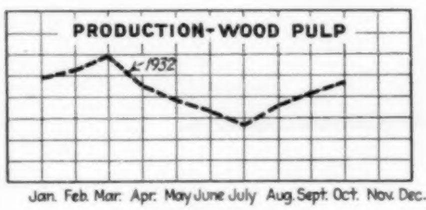


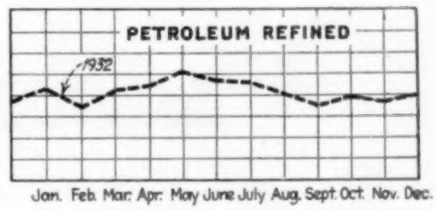
Based on electrical power consumption, data supplied by Electrical World

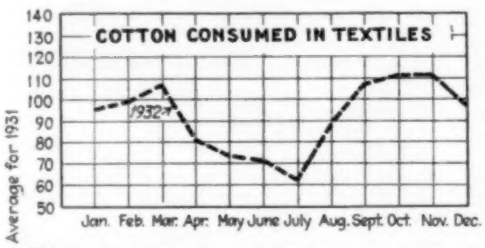


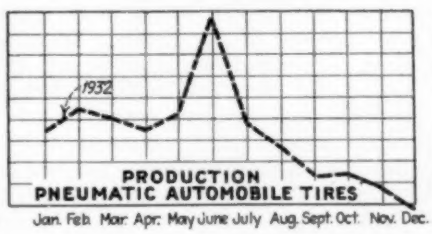
TRENDS OF PRODUCTION AND CONSUMPTION

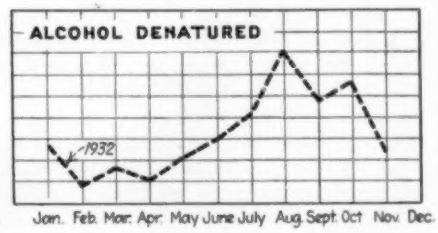


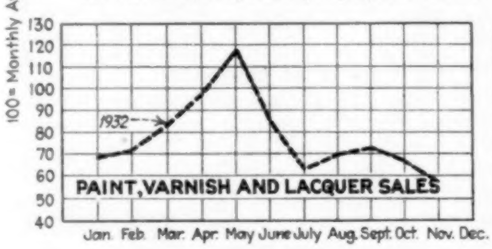


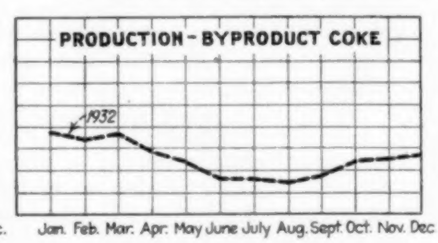


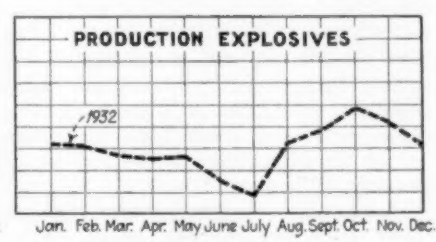


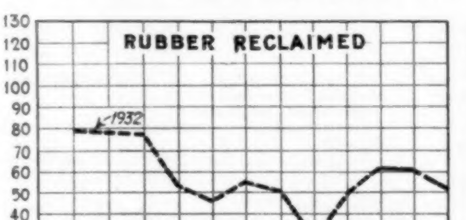


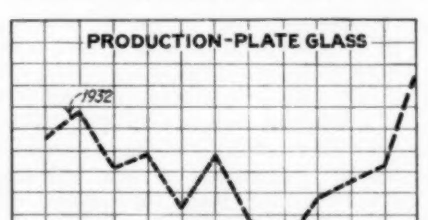


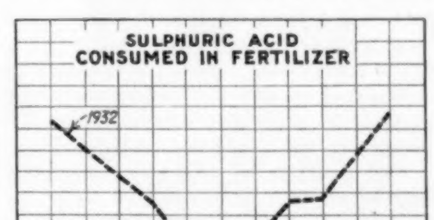


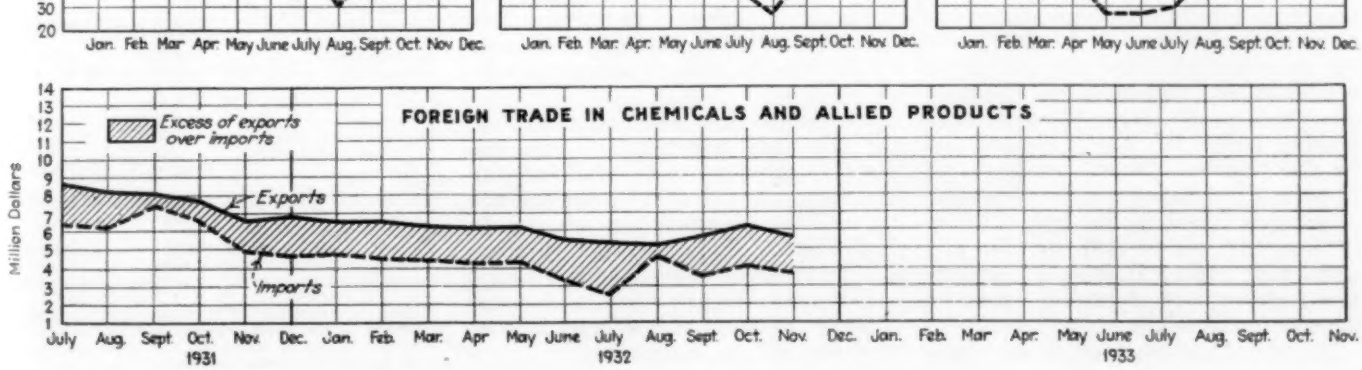












MARKETS

Demand for chemicals is spotted with some large consuming industries active and others operating on a conservative scale which extends to their requirements for raw materials. An easy price tone underlies the market but this results more from relatively light trading than to any basic condition of the market

DISTRIBUTION of chemicals made some progress in the last month with some consuming industries ordering out contract shipments in larger volume. Lacquer, fertilizer, and rayon producers are reported to have been large consumers of chemicals. The plate glass trade also has been more active and some of the flat glass factories have increased their outputs. The textile trade fell off somewhat in the closing part of last year but silk mills showed a good gain in January as compared with the preceding month although falling short of the output of January, 1932.

Many large consumers who did not cover 1933 requirements in the latter part of last year, have since then, placed long term orders. However the list is by no means 100 per cent complete and in the case of such important chemicals as mineral acids and alkalis, there are consumers who have not covered ahead.

The position of imported chemicals may be affected by restrictive measures which are under consideration. Proposals made include the assessing of import values on a basis of American selling price instead of the present foreign market value. Opposition to this proposal was voiced early this month at a hearing before the Tariff Commission by the National Council of American Importers and Exporters, Inc. A second proposal is found in the Hill bill now in Congress which calls for the imposition of additional duties on imports where depreciated currencies exist in the country of origin.

Imports of sodium sulphate have been the subject of controversy for some time. The crude material, or salt cake, is on the free list while anhydrous sodium sulphate has been subject to duty. Last year the customs authorities dismissed complaints that arrivals of sodium sulphate should fall in the dutiable classification but on Feb. 2 an order was issued withholding liquidation of crude sodium sulphate importations until official action has been taken on litigation now in the customs court.

Drop in Sulphur Output

A report from the Bureau of Mines states that domestic production of sulphur last year dropped to less than one-half of the quantity produced in 1931. The total for 1932 was 889,695 long tons, a decrease of 58 per cent, compared with the output of 2,128,930 long tons in 1931. Shipments declined from 1,376,526 long tons in 1931 to 1,108,112 long tons in 1932. Stocks at mines on Dec. 31 decreased to 3,031,000 long tons or 219,000 long tons below the record reserve at the close of the preceding year. Exports of sulphur last year were 351,509 tons compared with 407,586 tons for 1931 or a decline of 14 per cent.

The greater part of sulphur production last year centered in Texas but 13,401 long tons was produced in Louisiana. As one of the large producing companies is developing a new sulphur property in Louisiana, that State may figure prominently in the industry in 1934 when the new plant is expected to be in operation and shipments in a large way will be inaugurated.

Nitrate of soda has been moving more freely of late with southern consumers drawing upon warehouse stocks. Estimates place nitrate stocks now held in this country at about 300,000 tons. Recent developments in Chile have been of wide interest. While no definite plans for reorganizing the industry have yet been adopted it appears that the tenor of proposed changes is to place the industry under control of Chilean interests with the government setting up a sales organization which will be absolute in power to fix sales prices.

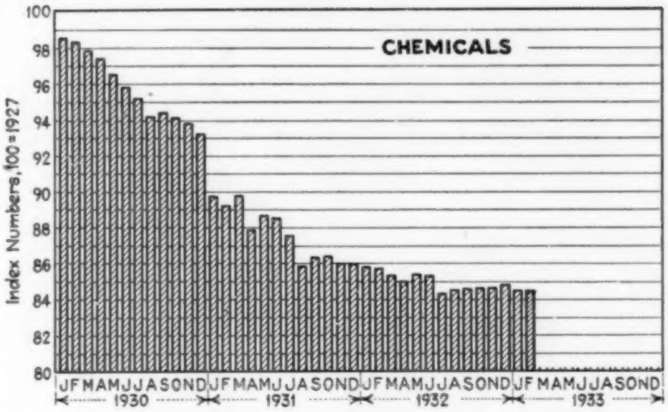
Following an announcement to the effect that ocean freights had been reduced from South Atlantic ports to the United Kingdom and to the Continent, a decided pick-up in export business in rosin was reported about two weeks ago. Later on trading in naval stores at primary points fell off and prices eased off as holders of stocks tried to stimulate buying interest.

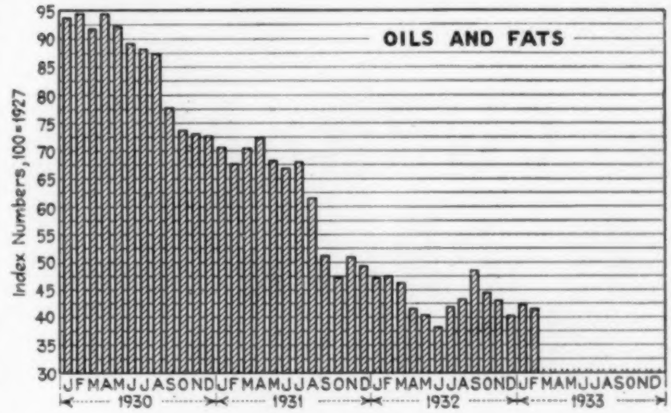
Production of Compressed and Liquefied Gases, 1931 and 1929

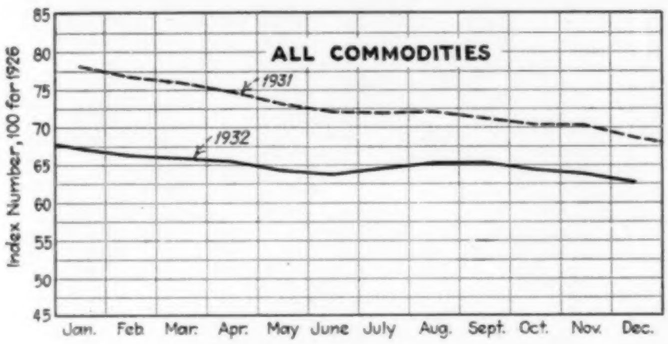
The figures for 1931 represent production; those for 1929 refer to sales (shipments or deliveries) by manufacturers. Where no separate figures are given for amounts made and consumed in the same establishments, the quantities and values relate to production for sale.

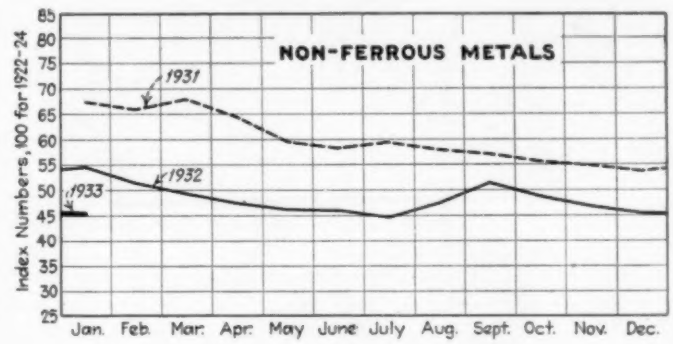
	1931	1929
Compressed and liquefied gases made in all industries, aggregate value	$56,455,106	$71,292,919
Made in the compressed and liquefied gas industry, value	$41,372,643	$51,622,803
Made as secondary products in other industries, value	$15,082,463	$19,670,116
Ammonia, anhydrous:		
Pounds	127,100,718	173,349,355
Value	$8,043,679	$10,673,234
Carbon dioxide (not including "dry ice"):		
Total production, pounds	178,570,183	(1)
Made and consumed in the same establishments in the production of "dry ice," pounds	26,896,186	1)
For sale—		
Pounds[2]	151,673,997	136,930,311
Value	$6,222,426	$6,931,735
"Dry ice" (solid carbon dioxide)—		
Pounds	84,954,018	(3)
Value	$2,899,738	(3)
Chlorine:		
Total production, pounds	361,739,705	398,943,703
Made and consumed in the same establishments, pounds	106,229,018	109,088,853
For sale—		
Pounds	255,510,687	289,854,850
Value	$5,248,496	$7,113,091
Acetylene:		
M cubic feet	741,039	969,534
Value	$12,867,449	$16,553,763
Hydrocarbon gases, other than acetylene, value	$1,613,714	$2,447,196
Hydrogen:		
M cubic feet	489,815	207,843
Value	$955,469	$1,423,456
Oxygen:		
Total production, M cubic feet	2,042,835	3,140,095
Liquefaction process	1,990,268	2,816,641
Electrolytic process	52,567	323,454
Value	$16,350,002	$23,409,606
Nitrous oxide:		
Thousands of gallons	94,607	109,812
Value	$922,626	$1,196,392
Sulphur dioxide:		
Pounds	16,104,534	17,600,936
Value	$839,021	$973,596
Other gases, value	$492,486	$570,850

[1] Data incomplete. [2] Includes approximately 80,000,000 pounds piped to plants making "dry ice." [3] Withheld to avoid disclosing the production reported by individual establishments.









PRICE TRENDS—CHEM. & MET.'S WEIGHTED INDEXES

THERE have been a few cases where chemical prices in the last month have been decidedly weak due to the very keen competition which has developed on the selling side. The quest to line up contract business in some lines has continued the private terms basis of negotiation with buyers generally getting the benefit. With these exceptions, the resistance to lower prices has been sufficient to encourage the view that values have reached a level about as low as they will go.

Competition with price concessions on contract business is nothing new and can be eliminated as indicating a trend. Price weakness in sodium phosphates is reported to have followed attempts to work off surplus holdings and apparently production has gone ahead at a pace too rapid to find consuming outlets. Bichromates have been under pressure because with declining amounts going into consumption in the last year, there has been an increased activity on the part of producers to hold their production up as well as possible and the result has been record low prices. Cream of tartar is another material which has been under pressure and it has been tending steadily downward in price.

Factors which might influence upward revisions in prices generally are reduced to the possibility of enlarged buying demands. Any return of sustained buying admittedly would bring about price recoveries but there is very little sentiment found in favor of any nearby uplift in present schedules.

Certain chemicals produced in foreign countries, largely because of depreciated currencies abroad, have had a depressing effect on values in domestic markets. In fact there are rumors that chemicals of foreign origin, which have not been prominent in our markets for some time, may regain some of their lost prestige. Tariff restrictions calculated to equalize the differences in exchange have been proposed but little hope is held out for any relief in that direction as the present Congress, according to latest advices, will not pass any of these measures. It is probable, however, that depreciated foreign currencies will be dealt with at the next session.

Vegetable oils and fats failed to maintain the price advance recorded a month ago. The background for cottonseed oil is not improved by reports that cotton acreage this season will be materially increased over that of last year. Production of this oil is dependent on the available supply of cotton seed and not on demand from consuming industries. Hence any indication that the seed supply is to be enlarged acts as a check on the advance of prices for the oil.

Linseed oil has passed through a long siege of subnormal consumption so that ordinary methods of figuring the price trend by the statistical position of flaxseed is at the most unreliable. The active consuming season is approaching and the price outook is favorable to crushers.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**84.54**
Last month	84.54
February, 1932	85.70
February, 1931	89.16

While the weighted index number for the month was unchanged, there were numerous price fluctuations with the larger number on the down side. Higher average prices for turpentine was a balancing factor. Bichromates, sodium phosphates, ethyl and amyl acetates were openly reduced in price.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**41.70**
Last month	42.46
February, 1932	47.47
February, 1931	67.92

Cottonseed and linseed oils reached lower levels during the month and were most prominent in the reduction of the weighted number. Tallow also was offered at reduced figures and in general an easy tone ruled in the general market for oils and fats.

CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Feb. 13.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.10 -$0.11	$0.10 -$0.11	$0.10 -$0.11
Acid, acetic, 28%, bbl., cwt	2.65 - 2.90	2.65 - 2.90	2.40 - 2.65
Glacial 99%, tanks	8.89 -	8.89 -	8.10 - ......
drs	9.14 - 9.39	9.14 - 9.39	8.35 - 8.60
U. S. P. reagent, c'bys	9.64 - 9.89	9.64 - 9.89	8.85 - 9.10
Boric, bbl., lb	.04½- .05	.04½- .05	.06½- .07
Citric, kegs, lb	.29 - .31	.29 - .31	.33½- .35
Formic, bbl., lb	.10 - .11	.10 - .11	.10 - .11
Gallic, tech., bbl., lb	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb., lb	.06 - .07	.06 - .07	.06 - .07
Latic, 44%, tech., light, bbl., lb	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18° tanks, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -......	18.50 -20.00
Oxalic, crystals, bbl., lb	.11 - .11½	.11 - .11½	.11 - .12
Phosphoric, tech., c'bys., lb	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton	15.50 -......	15.50 -......	15.50 -......
Tannic, tech., bbl., lb	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb	.20 - .21	.20 - .21	.25½- .26
Tungstic, bbl., lb	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, ethyl, 190 p'f., bbl., gal	2.53½-......	2.53½-......	2.53½-......
Alcohol, Butyl, tanks, lb	.113-......	.113-......	.143-......
Alcohol, Amyl	......-......	......-......	......-......
From Pentane, tanks, lb	.143-......	.182-......	.203-......
Denatured, 190 proof			
No. 1 special dr., gal	.34½-......	.34½-......	.34½-......
No. 5, 188 proof, dr., gal	.38½-......	.38½-......	.35½-......
Alum, ammonia, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags, cwt	1.25 - 1.40	1.25 - 1.40	1.25 - 1.40
Iron free, bg., cwt	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb	.02½- .03	.02½- .03	.02½- .03
tanks, lb	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb	.15½- .15½	.15½- .15½	.15½- .15½
tanks, lb	.05 -......	.05 -......	.05½-......
Ammonium carbonate, powd. tech., casks, lb	.08 - .12	.08 - .12	.10½- .11
Sulphate, wks., cwt	1.00 -......	1.025-......	1.10 -......
Amylacetate tech., tanks, lb., gal	.135-......	.16 -......	.16 -......
Antimony Oxide, bbl., lb	.07 - .08	.07 - .08	.06½- .08
Arsenic, white, powd., bbl., lb	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs, lb	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	63.00 -65.00	63.00 -65.00	63.00 -65.00
Nitrate, cask, lb	.07½- .07½	.07½- .07½	.07 - .07½
Blanc fixe, dry, bbl., lb	.03 - .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt	1.75 - 2.00	1.75 - 2.00	1.75 - 2.00
Borax, grain, bags, ton	40.00 -45.00	40.00 -45.00	50.00 -57.00
Bromine, cs., lb	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.50 -......	2.50 -......	2.00 -......
Arsenate, dr., lb	.05½- .06½	.05½- .06½	.06 - .07
Carbide drums, lb	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton	18.00 -......	18.00 -......	18.00 -......
flake, dr., wks., ton	21.00 -......	21.00 -......	21.00 -......
Phosphate, bbl., lb	.07½- .08	.07½- .08	.08 - .08½
Carbon bisulphide, drums, lb	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb	.01¾-......	.01¾-......	.01¾-......
Cylinders	.05½- .06	.05½- .06	.04 - .06
Cobalt oxide, cans, lb	1.25 - 1.35	1.25 - 1.35	1.35 - 1.45

	Current Price	Last Month	Last Year
Copperas, bgs., f.o.b. wks., ton	14.00 -15.00	13.00 -14.00	13.00 -14.00
Copper carbonate, bbl., lb	.07 - .16	.07 - .16	.07 - .16
Cyanide, tech., bbl., lb	.39 - .44	.39 - .44	.39 - .44
Sulphate, bbl., cwt	3.00 - 3.25	3.00 - 3.25	3.10 - 3.25
Cream of tartar, bbl., lb	.14½- .15	.15½- .16	.19½- .20
Diethylene glycol, dr., lb	.14 - .16	.14 - .16	.14 - .16
Epsom salt, dom., tech., bbl., cwt	1.70 - 2.00	1.70 - 2.00	1.70 - 2.00
Imp., tech., bags, cwt	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb	.09 -......	.09½-......	.10 -......
Formaldehyde, 40%, bbl., lb	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal	1.10 - 1.20	1.10 - 1.20	1.10 - 1.20
Refined, dr., gal	1.80 - 1.90	1.80 - 1.90	1.80 - 1.90
Glaubers salt, bags, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb	.10½- .10½	.10½- .10½	.11½- .11¾
Lead:			
White, basic carbonate, dry casks, lb	.06 -......	.06 -......	.06½-......
White, basic sulphate, sck., lb	.05½-......	.05½-......	.06 -......
Red, dry, sck., lb	.06½-......	.06½-......	.06¾-......
Lead acetate, white crys., bbl., lb	.10 - .11	.10 - .11	.10½- .11
Lead arsenate, powd., bbl., lb	.09 - .13	.09½- .14	.10 - .14
Lime, chem., bulk, ton	8.50 -......	8.50 -......	8.50 -......
Litharge, pwd., csk, lb	.05½-......	.05½-......	.05¾-......
Lithophone, bags, lb	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb	.05¾- .06	.05¾- .06	.05¾- .06
Methanol, 95%, tanks, gal	.33 -......	.33 -......	.33 -......
97%, tanks, gal	.34 -......	.34 -......	.34 -......
Synthetic, tanks, gal	.35½-......	.35½-......	.35½-......
Nickel salt, double, bbl., lb	.11 - .11½	.11 - .11½	.10½- .11
Orange mineral, csk., lb	.09 -......	.09 -......	.09½-......
Phosphorus, red, cases, lb	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb	.28 - .32	.28 - .32	.31 - .32
Potassium bichromate, casks, lb	.07 - .08	.07 - .08	.08 - .08½
Carbonate, 80-85%, calc. csk., lb	.05 - .05½	.05 - .05½	.05 - .06
Chlorate, powd., lb	.08 - .08½	.08 - .08½	.08 - .08½
Hydroxide (c'stic potash) dr., lb	.06½- .06¾	.06½- .06¾	.06½- .06¾
Muriate, 80% bgs., ton	37.15 -......	37.15 -......	37.15 -......
Nitrate, bbl., lb	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb	.17½- .18	.18½- .19	.18½- .19
Sal ammoniac, white, casks, lb	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	16.00 -18.00
Soda ash, light, 58%, bags, contract, cwt	1.20 -......	1.20 -......	1.15 -......
Dense, bags, cwt	1.22½-......	1.22½-......	1.17½-......
Soda, caustic, 76%, solid, drums, contract, cwt	2.50 - 2.75	2.50 - 2.75	2.50 - 2.75
Acetate, works, bbl., lb	.04½- .05	.05 - .06	.05 - .05½
Bicarbonate, bbl., cwt	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb	.044- .05	.04½- .05	.05½- .06
Bisulphate, bulk, ton	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb	.03¾- .04	.03¾- .04	.03¾- .04
Chlorate, kegs, lb	.05½- .07½	.05½- .07½	.05½- .07½
Chloride, tech., ton	12.00 -14.75	12.00 -14.75	12.00 -14.00
Cyanide, cases, dom., lb	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb	.07 - .08	.07½- .08	.07½- .08
Hyposulphite, bbl., lb	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt	3.60 3.75	3.60 - 3.75	3.60 - 3.75
Nitrate, bags, cwt	1.295-......	1.295-......	1.77 -......
Nitrite, casks, lb	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb	.018- .02	.018- .02	.0265 - .03
Prussiate, yel. drums, lb	.11½- .12	.11½- .12	.11½- .12
Silicate (40° dr.) wks. cwt	.70 - .75	.70 - .75	.70 - .75
Sulphide, fused, 60-62%, dr., lb	.02¾- .03½	.02¾- .03	.02¾- .03
Sulphite, cyrs., bbl., lb	.03 - .03½	.03 - .03½	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -......	18.00 -......	18.00 -......
Chloride, dr., lb	.03½- .04	.03½- .04	.05 - .06
Dioxide, cyl., lb	.06½- .07	.06½- .07	.06½- .07
Flour, bag, cwt	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb	nom.-......	nom.-......	nom.-......
Oxide, bbl., lb	.27½-......	.27½-......	.24½-......
Crystals, bbl., lb	.24 -......	.24 -......	.23½-......
Zinc chloride, gran., bbl., lb	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl., lb	.10½- .11	.10½- .11	.10½- .11
Cyanide, dr., lb	.38 - .42	.41 - .42	.41 - .42
Dust, bbl., lb	.04½- .06	.04½- .05	.05½- .06
Zinc oxide, lead free, bag, lb	.05¾-......	.05¾-......	.06¾-......
5% lead sulphate, bags, lb	.05½-......	.05½-......	.06¾-......
Sulphate, bbl., cwt	3.00 - 3.25	3.00 - 3.25	3.00 - 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.08¾-$0.09	$0.08¾-$0.09	$0.09½-$0.10
Chinawood oil, bbl., lb	.05½-......	.05 -......	.07½-......
Coconut oil, Ceylon, tanks, N. Y. lb	.03 -......	.03 -......	.03½-......
Corn oil crude, tanks, (f.o.b. mill), lb	.03 -......	.02¾-......	.03½-......
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.02¾-......	.03 -......	.03½-......
Linseed oil, raw car lots, bbl., lb	.072-......	.074-......	.064-......
Palm, Lagos, casks, lb	.02¾-......	.03 -......	.04 -......
Palm Kernel, bbl., lb	.04½-......	.04½-......	.05½-......
Peanut oil, crude, tanks (mill), lb	.03¾-......	.03 -......	.03¾-......
Rapeseed oil, refined, bbl., gal	.35 - .36	.31 - .32	.39 - .41
Soya bean, tank (f.o.b. Coast), lb	nom.-......	nom.-......	nom.-......
Sulphur (olive foots), bbl., lb	.04½-......	.04½-......	.04¾-......
Cod, Newfoundland, bbl., gal	.19 - .21	.22 - .24	.25 - .27
Menhaden, light pressed, bbl., gal	.25½- .26	.27 - .28	.33 - .34
Crude, tanks (f.o.b. factory), gal	.09 -......	.10 -......	.20 -......
Grease, yellow, loose, lb	.02 -......	.02½-......	.02¾-......
Oleo stearine, lb	.03¾-......	.03½-......	.04¾-......
Red oil, distilled, d.p. bbl., lb	.06 -......	.06½-......	.07½-......
Tallow, extra, loose, lb	.01¾-......	.02½-......	.02¾-......

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1.25
Benzidine base, bbl., lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs, lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.20 – .21	.20 – .21	.20 – .21
Beta-naphthol, tech., drums, lb.	.22 – .24	.22 – .24	.22 – .24
Cresol, U. S. P., dr., lb.	.10½– .11	.10½– .11	.10½– .11
Cresylic acid, 97%, dr., wks., gal.	.42 – .45	.49 – .52	.49 – .52
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl. lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil 25% dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.04¾– .05	.04¾– .05	.03¾– .04¼
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14¼– .15	.14¼– .15	.14¼– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	.90 – .95	.90 – .95	1.50 – 1.80
R-salt, bbl., lb.	.40 – .44	.40 – .44	.40 – .44
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.33 – .35
Solvent naphtha, w.w., tanks, gal.	.26 –......	.26 –......	.26 –......
Tolidine, bbl., lb.	.88 – .90	.88 – .90	.86 – .88
Toluene, tanks, works, gal.	.30 –......	.30 –......	.30 –......
Xylene, com., tanks, gal.	.26 –......	.26 –......	.26 –......

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.07 – .10½	.06 – .10½	.07½– .14
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.02¾– .20	.02¾– .20	.03 – .20
Prussian blue, bbl., lb.	.35 – .36	.35 – .36	.35 – .36
Ultramine blue, bbl., lb.	.06 – .32	.06 – .32	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.27 – .30
Carmine red, tins, lb.	3.90 – 4.50	3.90 – 4.50	5.25 – 5.40
Para toner, lb.	.80 – .85	.80 – .85	.75 – .80
Vermilion, English, bbl., lb.	1.10 – 1.20	1.10 – 1.20	1.45 – 1.50
Chrome yellow, C. P., bbl., lb.	.15 – .15½	.15 – .15½	.16 – .16½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.06 – .08	.06 – .08	.06 – .08
Manila, bags, lb.	.16 – .17	.16 – .17	.16 – .17
Damar, Batavia, cases, lb.	.16 – .16½	.16 – .19	.16 – .16½
Kauri No. 1 cases, lb.	.45 – .48	.45 – .48	.45 – .48
Kieselguhr (f.o.b. N.Y.), ton	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton	40.00 –......	40.00 –......	40.00 –......
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	4.00 –......	3.90 –......	3.80 –......
Turpentine, gal.	.44½–......	.44 –......	.38½–......
Shellac, orange, fine, bags, lb.	.19 – .20	.20 – .25	.32 – .34
Bleached, bonedry, bags, lb.	.18 – .19	.18 – .19	.24 – .26
T. N. bags, lb.	.08½– .09	.09½– .10	.12 – .13
Soapstone (f.o.b. Vt.), bags, ton	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b Ga.), ton	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton	13.75 –.....	13.75 –.....	13.75 –.....
Wax, Bayberry, bbl., lb.	.14 – .15	.16 – .18	.16 – .20
Beeswax, ref., light, lb.	.20 – .30	.20 – .30	.25 – .27
Candelilla, bags, lb.	.10 – .11	.11 – .12	.14 –.....
Carnuba, No. 1, bags, lb.	.21½– .22	.23 – .24	.23 – .24
Paraffine, crude 105-110 m.p., lb.	.03½– .03¾	.03½– .03¾	.03½– .03¾

Price Changes During Month

Advanced	Declined
China Wood oil	Ammonium sulphate
Rosin	Cream of tartar
Turpentine	Ethyl acetate
Mercury	Cottonseed oil
	Linseed oil
	Tallow
	Platinum
	Chrome ore
	Bichromate of soda

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton	$200.00–.....	$200.00–.....	$200.00–.....
Ferromanganese, 78-82%, ton	68.00–.....	68.00–.....	80.00–85.00
Ferrochrome, 65-70%	.09½–.....	.09½–.....	.11–.....
Spiegeleisen, 19-21% ton	25.00–.....	25 00–.....	30.00–.....
Ferrosilicon, 14-17%, ton	31.00–.....	31.00–.....	31.00–.....
Ferrotungsten, 70-80%, lb.	.94– 1.00	.94– 1.00	1.00– 1.10
Ferrovanadium, 30-40%, lb.	2.60– 2.80	2.60– 2.80	3.15– 3.50

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.05 –......	$0.05 –......	$0.06 –......
Aluminum, 96-99%, lb.	.229–......	.229–......	.233–......
Antimony, Chin. and Jap., lb.	.058–......	.05½–......	.06½–......
Nickel, 99%, lb.	.35 –......	.35 –......	.35 –......
Monel metal blocks, lb.	.28 –......	.28 –......	.28 –......
Tin, 5-ton lots, Straits, lb.	.235–......	.023–......	.20½–......
Lead, New York, spot. lb.	.03 –......	.03 –......	.03½–......
Zinc, New York, spot, lb.	.03¼–......	.0342–......	.0345–......
Silver, commercial, oz.	.25¾–......	.25½–......	.30 –......
Cadmium, lb.	.55 –......	.55 –......	.55 –......
Bismuth, ton lots, lb.	.85 –......	.85 –......	1.50 –......
Cobalt, lb.	2.50 –......	2.50 –......	2.50 –......
Magnesium, ingots, 99%, lb.	.30 –......	.30 –......	.30 –......
Platinum, ref., oz.	24.00 –......	28.00 –......	40.00 –......
Palladium, ref., oz.	16.00 – 17.00	17.00 – 18.00	19.00 – 21.00
Mercury, flask, 75 lb.	49.00 – 50.00	48.00 – 49.00	65.00 – 67.00
Tungsten powder, lb.	1.45 –......	1.45 –......	1.45 –......

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton	$6.50 –$8.25	$6.50 –$8.25	$6.50 –$8.25
Chrome ore, c. f., post, ton	14.00 –18.50	16.50 –19.00	17.00 –20.00
Coke, fdry., f.o b. ovens, ton	3.25 – 3.75	3.25 – 3.75	3.25 – 3.75
Fluorspar, gravel, f.o.b. Il., ton	17.25 –20.00	17.25 –20.00	17.25 –20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit	.19 –......	.19 – ...	.25 – .27
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.45 –......	.45 –......	.45 –......
Monazite, 6% of ThO_2, ton	60.00 –......	60.00 –......	60.00 –......
Pyrites, Span. fines, c.i.f., unit	.13 –......	.13 –......	.13 –......
Rutile, 94-96% TiO_2, lb.	.10 – .11	.10 – .11	.10 – .11
Tungsten, scheelite, 60% WO_3 and over, unit	8.00 –10.00	8.00 –10.00	10.50 –12.00

INDUSTRIAL NOTES

AMERICAN CREOSOTING Co., Louisville, Ky., has purchased plants and inventories of Gulf States Creosoting Co. located at Brunswick, Ga., Birmingham, Ala., Jackson and Hattiesburg, Miss., and Slidell, La.

MERCK & Co., Rahway, N. J., will dedicate on March 1 a new research laboratory which will be devoted to research in biochemistry and applied chemistry.

INTERNATIONAL SELLING CORP., New York, on Feb. 1 became exclusive sales agents for the Coignet Chemical Products Co., of France. W. E. Miller, former general representative of the Coignet company, will remain in charge.

POOLE FOUNDRY & MACHINE Co., Baltimore, Md., has appointed Frank M. Esch, Houston, Tex., as representative for Texas and Rockfield-Davis Equipment Co., Denver, Colo., representative for Colorado, Wyoming, and New Mexico.

CHEMICAL CONSTRUCTION CORP., New York, has moved its offices from 50 East 42d Street to 535 Fifth Avenue.

LEADER INDUSTRIES, Decatur, Ill., has named Ralph M. Torrey eastern representative. Mr. Torrey, who was formerly on the sales engineering staff of E. V. Badger & Sons Co., will be located in the New York office of his company at 22 East 40th Street.

THE FALK CORP., Milwaukee, Wis., has elected Edward P. Connell vice-president. Mr. Connell joined the company in 1913 and has been with it continuously since then. In 1924 he was made comptroller which office he will retain.

R. & H. CHEMICALS DEPARTMENT of E. I. duPont de Nemours & Co., Wilmington, Del., has opened an office at Charlotte, N. C., with R. M. Levy in charge. The sales office of the company in Cleveland, Ohio, has been moved to the Guardian Building.

LUDLUM STEEL Co., Watervliet, N. Y., has announced that C. B. Templeton, formerly assistant to the president, is now assistant to the vice-president in charge of sales.

LUMBER BI-PRODUCTS Co., with offices in M. & T. Trust Building, Buffalo, N. Y., was formed early in January to deal in byproducts of wood, cotton, waste, etc. M. J. Watson, with 12 years' experience in the wood flour industry, is president of the company.

BABCOCK & WILCOX Co., and the Babcock & Wilcox Tube Co. have appointed E. A. Livingston sales representative with headquarters at 85 Liberty St., New York.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	This Month		Cumulative to Date	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England.....	$40,000	$80,000	$165,000	$80,000
Middle Atlantic.....	180,000	356,000	808,000	431,000
Southern..........	28,000	....	173,000	181,000
Middle West.......	150,000	163,000	353,000	163,000
West of Mississippi	55,000	256,000	155,000	646,000
Far West..........	123,000	150,000	239,000	328,000
Canada...........	28,000	106,000	648,000	131,000
Total..........	$604,000	$1,111,000	$2,541,000	$1,960,000

PROPOSED WORK BIDS ASKED

Cement Plant — State Board of Corrections, c/o Ralph Wann, Canon City, Colo., is preparing to introduce bill in state legislature asking for construction of cement plant at State Penitentiary, Canon City, to produce state consumed cement.

Cosmetic Factory—Ybry, Inc., 50 West 57th St., New York, N. Y., has leased building at 513 West 33rd St., New York, and will alter and equip same for manufacture of cosmetics. Estimated cost with equipment $30,000.

Factory — Krank Co. Ltd., Winnipeg, Man., Can., manufacturer of shaving creams, plans an addition to its factory.

Confectionery Plant—Brown Candy & Cracker Co., 810 South Medina St., San Antonio, Tex., plans to construct a plant for the manufacture of candy, crackers, etc. Estimated cost $35,000.

Paint Factory—Adelphi Paint & Color Works, Old South Rd. and 86th St., Ozone Park, L. I., plans to alter and repair its factory here. Estimated cost with equipment $28,000.

Paint Factory — J. J. Hockings, 829 Broad St., Newark, N. J., plans the construction of a 3 story, 60 x 200 ft. paint factory on Frelinghuysen Ave. Estimated cost $100,000.

Paper Plant—Consolidated Paper Co., Monroe, Mich., plans to alter and repair No. 3 paper plant here. Estimated cost with equipment $28,000. Maturity indefinite.

Paper Plant—J. Lapolosa, 171 Remsen St., New Brunswick, N. J., is having plans prepared by H. I. Bach, Archt., 63 Shureman St., New Brunswick, for a paper manufacturing plant and storage building on Georges Rd., New Brunswick. Estimated cost $40,000.

Pottery Plant—Salem China Co., c/o F. H. Sebring, Sebring, O., will alter loft building into pottery plant. Estimated cost $30,000.

Rubber Plant—Cincinnati Rubber Co., Franklin Ave., Cincinnati, O., had plans prepared for altering its plant. Estimated cost $30,000. A. M. Ginney Co., c/o Owner, is engineer.

Scrap Building—Du Pont Viscoloid Co., H. R. Dorr, Ch. Engr., Lancaster St., Leominster, Mass., plans to rebuild its scrap building recently destroyed by fire. Estimated cost to exceed $20,000.

Soap Factory—Stockton Soap Co., Aurora and Washington Sts., Stockton, Calif., plans to rebuild soap factory recently destroyed by fire. Estimated cost $40,000.

Tar Plant—Neville Island Tar Co., Neville Island, Pittsburgh, Pa., plans to repair and install new equipment in its tar mixing plant here. Estimated cost $80,000. Maturity indefinite.

Factory—National Oil Products Co., Essex St., Newark, N. J., plans to construct a factory at Harrison, N. J. Estimated cost $50,000. Henry D. Scudder, 9 Clinton St., Newark, is architect.

Gasoline Skimming Plant—Corporation, c/o Joe Burnham, Texarkana, Ark., plans the construction of a gasoline skimming plant on Garland City-Texarkana Highway, Miller Co., Ark. Estimated cost $30,000.

Oil Plant—American Tung Oil Products Co., 30 Bay St., St. George, S. I., N. Y., plans the construction of a plant at Carriere, Miss. Estimated cost $28,000.

Refinery — Caldwell Refining Co., Caldwell, Idaho, plans the construction of an oil refinery. Estimated cost $150,000.

Refinery—Cities Service Co., 60 Wall St., New York, N. Y., plans to alter and install new still in its refinery at East Braintree, Mass. Estimated cost $60,000.

Refinery—Continental Oil Co., Carl Tillman, Supt., Florence, Colo., plans to rebuild refining still destroyed by explosion. Estimated cost $25,000.

Refinery—Crescent Refining Co., Holdenville, Okla., had preliminary plans prepared by H. H. Pegg, Engr., Allen, Okla., for a cracking plant at its refinery here. Estimated cost $40,000.

Refinery—Eclipse Refining Co., New Castle, Wyo., plans to construct an addition to its refinery. Estimated cost $30,000.

Refinery—Excell Petroleum Ltd., 6376 Clark St., Montreal, Que., plans to alter and repair its refinery. Estimated cost with equipment $28,000.

Refinery—Grey Oil & Refining Co., Greybull, Wyo., plans the construction of a small oil refinery here. Address J. A. Alderdice, Greybull.

Refinery — Keystone Refining Co., 12800 Northampton Ave., Detroit, Mich., plans to repair its refinery. Estimated cost to exceed $75,000.

Refinery—Lloyd Refining Co., L. B. Lloyd, Pres., 329 Rose Park Dr., Toronto, Ont., Can., has acquired a site at Port Credit, Ont., and plans to construct a refinery. Estimated cost to exceed $50,000.

Refinery—Southern Crude Oil Refining Co., P. J. Stapp in charge, Texarkana, Ark., plans the construction of a refinery in Miller County. Estimated cost $40,000.

Equipment—Canadian Carborundum Co. Ltd., St. Canute, Que., Can., is in the market for equipment for its silica plant.

Equipment—Canadian Leather Co. Ltd., Winnipeg, Man., is interested in prices of equipment.

Grinding Machinery—G. H. Gillespie & Co. Ltd., Madoc, Ont., manufacturer of soapstone and talc, is interested in prices on grinding machinery and other equipment.

CONTRACTS AWARDED

Alcohol Plant—American Commercial Alcohol Corp., Delaware Ave. and Tasker St., Philadelphia, Pa., awarded contract for tank and tank house to S. H. Levin, 1619 Sansome St., Philadelphia. Estimated cost $28,000.

Factory — Flintkote Co., Maple St., East Rutherford, N. J., awarded contract for factory on Maple St., to Ferber Construction Co., 16 Johnson Ave., Hackensack, N. J. Estimated cost with equipment $28,000.

Foundry—Fuchs & Lang Manufacturing Co. (division of General Printing Ink Corp.), 309 Sussex St., Harrison, N. J., awarded contract for altering foundry on Central Ave., East Rutherford, to Mahoney-Troast Contracting Co., Inc., 657 Main Ave., Passaic, N. J. Estimated cost $28,500.

Gypsum Factory—U. S. Gypsum Co., 816 West 5th St., Los Angeles, Calif., awarded contract for 1 story, 56 x 360 ft. factory at Midland, near Riverside, Calif., to Austin Co. of California, 777 East Washington St., Los Angeles.

Refinery—Associated Oil Co., 79 New Montgomery St., San Francisco, Calif., awarded contract for refinery units at Avon, Calif.: treating plant to Dinwiddie Construction Co., Crocker Bldg., San Francisco, $9,000; pumping plant to Lindgren & Swinerton, Inc., 1723 Webster St., Oakland, $6,000.

Refinery — Coastal Petroleum Corp., Mobile, Ala., awarded contract for one 55,000 bbl. and two 200 bbl. bulk storage tanks at plant at Blakeley Island, to Chicago Bridge & Iron Works, 37 West Van Buren St., Chicago. Estimated cost to exceed $28,000.

Refinery — Marathon Oil Co., Tulsa, Okla., awarded contract for cracking unit at refinery at Bristow, to M. W. Kellogg Co., 225 Bway., New York, N. Y. Estimated cost to exceed $30,000.

Refinery—Quaker State Oil Refining Co., c/o T. M. Koch, Oil City, Pa., will construct an addition to its refinery, including bulk storage tanks, pumping plant, etc., at Farmers Valley, Pa. Work will be done by separate contracts. Estimated cost $30,000.

Stabilizing Plant — Magnolia Petroleum Co., Corsicana, Tex., plans the construction of a stabilizing plant. Estimated cost $25,000. Work will be done by day labor.

Process Plant—Canadian Diatomite Ltd., 517 Sayward Bldg., Victoria, B. C., awarded contract for 50 x 100 ft. process plant for manufacture of insulation products, including bricks, to W. Calder, 82 San Juan Ave., Victoria, B. C.

Rubber Factory—B. F. Goodrich Co., Akron, O., awarded contract for plant at Indianapolis, Ind., to W. P. Jungclaus, 825 Massachusetts Ave., Indianapolis. Estimated cost $50,000.

Soap Factory—Carman & Co., 629 West 27th St., New York, N. Y., awarded contract for factory on Division St., Boonton, N. J., to be leased to Wecoline Products, Inc., Boonton, to John K. Cooke & Son, Inc., 210 Clifton Blvd., Clifton, N. J. Estimated cost $35,000.

Soap Factory — Colgate-Palmolive-Peet Co., Jeffersonville, Ind., will remodel and install new equipment in its soap factory here. Estimated cost $100,000. Work will be done by day labor and separate contracts.

Paint Factory—Baker Paint & Varnish Co., 228 Suydam Ave., Jersey City, N. J., awarded contract for rebuilding its factory recently destroyed by fire to W. Robertson & Son, 15 Exchange Pl., Jersey City, N. J. Estimated cost $30,000.

Warehouse—Healey-Seaver Co., 90 Freeport St., Dorchester, Mass., awarded contract for 1 story, 80 x 90 ft. warehouse at its glue factory, to Blake & White, 35 Wessagusett St., North Weymouth, Mass.

Warehouse — Acme White Lead & Color Works, Los Angeles, Calif., awarded contract for warehouse on Alosta St., to Austin Co. of California, 777 East Washington St., Los Angeles. Estimated cost $40,000.

Warehouse — Sherwin-Williams Co. of California, 652 Mateo St., Los Angeles, paint manufacturers, awarded contract for warehouse on Alosta St., to Austin Co. of California, 777 East Washington St., Los Angeles. Estimated cost $40,000.